BACHELOR THESIS

‘Integrated Care Programme for older in- and out-patients at the University Hospital of Getafe’

Author: Alberto Sánchez Sánchez

Degree: Biomedical Engineering

Tutor: Elena Villalba Mora, PhD

Juan José Vaquero López, PhD

Universidad Carlos III de Madrid

Escuela Politécnica Superior

Leganés, Junio 2015

Hospital Universitario de Getafe
SaludMadrid
Comunidad de Madrid

Instituto de Investigación Sanitaria Getafe

Table of Contents

Table of Figures

Tables

0 Acknowledgments

Me gustaría darle las gracias en primer lugar a Elena Villalba, mi tutora y mentora. Gracias por este año maravilloso en la Fundación. Gracias por enseñarme tantas cosas, como tu alumno y como persona. Gracias por devolverme la ilusión por ser ingeniero y por parecerme a ti en un futuro. Gracias por valorarme, por hacerme ver que el esfuerzo merece la pena, y que no hay barreras para quien quiere superarlas. Gracias por tu vocación, por tu valentía por superar todo lo que viene en contra y por ser la gran persona que eres. No me puedo imaginar una jefa mejor.

Graciasa todos mis compañeros de la Fundación de Investigación, especialmente a mis compañeros de despacho, Nacho y Fran. Gracias por apoyarme en todo. Gracias por vuestros ánimos en este año tan difícil. Gracias por tratarme como uno más desde el primer día, y por compartir fatigas, risas y mesa conmigo. Gracias por hacer que lo único malo de ir a trabajar fuese madrugar. Gracias por vuestra comprensión y por ser, de alguna forma, dos tutores más.

Gracias a todos los profesionales del Hospital Universitario de Getafe que han participado en este proyecto de una forma completamente desinteresada. Sin su contribución hubiese sido imposible desarrollar este sistema. Gracias por su tiempo, sus consejos y sus ideas.

Por último, gracias a mi familia. Gracias a todos por no dejarme abandonar. Gracias por obligarme a demostrarme que era capaz. Gracias por creer en mí cuando yo había perdido la esperanza. Si algún día puedo decir que soy ingeniero es gracias a vosotros. Gracias a mis hermanos por aguantarme, sé que no es fácil. Gracias papá y mamá por darnos la vida y por dar la vuestra por nosotros. Gracias por hacer que sigamos siendo uno, pase lo que pase. Esto, como todo lo que conseguimos, es también vuestro. Espero que estéis orgullosos. Os quiero mucho.

1 Introduction

The present document reports the research that I, Alberto Sánchez Sánchez (student of the Bachelor's Degree in Biomedical Engineering at Universidad Carlos III de Madrid), performed at the Instituto de Investigación Sanitaria de Getafe (Getafe Institute for Health Research, IISG hereafter). This research institution is located at the Hospital Universitario de Getafe (University Hospital of Getafe-HUG) and merges the efforts of the Fundación para la Investigación Biomédica del Hospital Universitario de Getafe (Biomedical Research Foundation of the University Hospital of Getafe-FIBHUG) and the Universidad Europea de Madrid (European University of Madrid-UEM). The establishment of this joint Institute aims to promote and coordinate research and innovation and maximize their impact on healthcare. The Institute focus is a multidisciplinary centre that focuses in different research lines such as: molecular and cellular biology, epidemiology, clinical research, active ageing, cognitive impairment in elderly patients, falls and fractures, management of chronic patients, application of technological solutions for health and social care, etc. Moreover, the inclusion of the UEM and the agreements signed with some universities (Universidad Carlos III de Madrid and Universidad Politécnica de Madrid) target the implementation of undergraduate and graduate education offer.

The FIBHUG is a perfect place to perform research in the potential application of technology in healthcare. It is integrated in a reference Hospital, so researchers can hold continuous interaction with healthcare professionals. Moreover, they can take advantage of the availability of patients for clinical trials and pilots. In fact it has become a reference site for the development of European-funded research projects. Indeed, they are currently carrying out 8 European Projects for the elderly, of which 2 out of them are focused on the use of ICTs for that population segment: ACANTO (A cyberphysical social networks using robots friends) is developing a robotic walker to assist older people with functional impairments; and DECI (Digital Environments for Cognitive Inclusion) is implementing and piloting digital services for mild cognitive impairment.

I joined the eHealth Unit, headed by Elena Villalba Mora, in August 2014. This unit focuses on the application of eHealth and telemedicine solutions for the remote assessment of elderly and chronically diseased patients. Besides, the Unit works also in the innovation of healthcare models and the integration of services for the efficient provision of health services. During my participation in European projects I was able to know the integrated care model implemented at the HUG and to identify some barriers that were preventing the achievement of complete integration, together with my colleagues at the eHealth unit. One of these barriers is the lack of communication pathways within the Geriatrics Service and with the rest of Services in the Hospital. In this sense, the eHealth Unit decided to take part in the integrated care model and contribute to the overcoming of this problem. At this point the idea of an integrated HIS arose, and my tutor suggested the alignment of the designing of the system with the completion of my Bachelor Thesis.

Thus, the main goal of this Thesis is the analysis and design of a HIS for the improvement of the Integrated Care Program at HUG. Thus, the rationale of this Thesis is not the development of any industrial product but the validation of a concept.

Concretely, this Thesis comprises the following objectives:

1 To carry out a comprehensive analysis of the environment at the Geriatrics Service.

2 To interact directly with users and engage them in the development of the HIS model.

3 To develop scenarios describing how the system would solve the problems in the Geriatrics Service.

4 To design the HIS, including data and user interaction models.

5 To develop Me-Fi prototypes

6 To validate my systems in terms of usability and user experience.

In order to fulfil all these goals I devised a strategy following **scenario-based design method.** The process was divided in 3 phases that were carried out from January to May 2015. They were time bounded and overlapped at some points of the process.

Phase 1: Analysis of the Environment at the Geriatrics Service. Identification of the main barriers for integration

January-March 2015

In order to develop the health information system it is crucial to monitor accurately the real problems in the integrated care program and the possible solutions enabling integration. Moreover the system should align with the Disease Management Processes and clinical pathways in the Integrated Care Program, so a deep-analysis of how the Service is managed was mandatory to promote support instead of disruption. The comprehensive analysis of the system was performed following Case-study research, and was based in direct observation, face to face interviews with relevant stakeholders and the review of documentation.

Phase 2: Creation of scenarios and development of first prototypes. Formative evaluation by Geriatricians

March-April 2015

One of the crucial aspects of my Thesis was the collaboration with final users (Geriatricians) in the Service. I had the chance to integrate in the multidisciplinary team at the hospital and get inputs from every professional. Thus I harvested h standpoints and insights which would may not had been considered otherwise. Their commitment and confidence in the system is imperative for the success of the model. Key aspects such as usability, appropriateness and system robustness must be built over user's desires and claims. The definition of scenarios will collect all this information and human preferences and will become the reference for future model refinement, development and final implementation. Then, data models, information pathways and the interaction user-computer can be devised. The iterative evaluation of the growing

system and the feedback from professionals empowered me to continuously improve the system and align closer to the real requirements in the system.

Phase 3: Development of the final mock-up and summative evaluation of the system by professionals. Validation of the Health Information System

April-May 2015

After the delivery of several subsequent versions of the system, a final one was agreed with the physicians collaborating to the project. Then, I carried out summative evaluation in order to validate the design and the acceptance by the main beneficiaries of a solution like this. Validation would be the first step for further and future implementation in regular care delivery. Nevertheless the scope of this Bachelor Thesis does not go beyond prototype validation.

2 Methods

After an initial revision of different research methods, I decided to follow a **Scenario-based design method (SDM)** for the development of the new Health Information System model at the Geriatrics Service. Under this paradigm the use of a future system is described at an early point in the development process. As the rest of user-centred approaches, SDM focuses on the description of how people will use the system to accomplish certain tasks rather than on functional specifications. The building blocks for the designing process are **scenarios**. They are a combination of (1) a setting or situations (environment); (2) one or more actors with certain features (e.g. knowledge, capabilities, personal and organisational goals); and (3) a set of tools or objects that actors manipulate for some purpose. Moreover, the description of the usage includes the portrayal of the series of actions and events that lead to an outcome. These actions and events are directly linked with the motivations, plans and reactions of involved actors. The devised usages in each scenario constitute the starting point for the engineering of the final product. Moreover they determine the steps to follow to build and refine models, prototypes and final systems.

The system aims to serve a very specific and well-defined segment of users, and their inclusion in the designing process seemed to be the most appropriate approach. Other elements like processes and involved data sets were also relevant and were also compatible with this kind of methodology, as they are well-known and do not need any modification for the improvement of the integrated care program. Besides, it made sense to apply a methodology complying with users' preferences, skills and behaviours, and moreover adapted to their requirements. Despite the functionalities of the system are important, it would be senseless to design data and information network models setting aside what the users really need and how they will use the solution.

Furthermore, in SDM the role of the designer is to facilitate the task for users and to make sure they are able to make benefit from the product as intended, with a minimum effort to use it (Abras, 2004). The involvement of actual users in the environment in which they would use the product being designed is a natural evolution in the field of user centred design. Users became a central part of the development process and their involvement lead to more effective, efficient and safer products and contributed to the acceptance and success of the final models (Preece, 2007).

Although SDM require an initial extra workload in comparison to other methods, I decided to implement my research in this way for several reasons: (Rosson, 2002)

- First, it is more adequate than solution-first problem-solving strategies, as it covers not only the problem, options available and goals, but also the environment designers deal with and user's standpoint. Solution-first approaches are faster, energizing and efficient, but they may poorly fit the real requirements of the scope of application.

- Second, SDM are more suitable for dynamic situations as they face the design from a holistic approach. Some designers have tried to solve the main problem dividing it into some sets of sub-problems. Although they readily find fully specifies sub-solutions by the time all specified sub-solutions are merged, the requirements of the problem may have already changed. Contrarily, the comprehensive standpoint of SDM allows designers to get a more complete overview and seamless perception of the whole and concrete scenario. Thus, whenever it evolves, designers can better respond and adapt the solution to new demands. Finally, scenarios are rough entities, and designers may smoothly modify them to match it to the devised designs.

- Apart, SDM maintain the orientation to people and their needs, rather than on the technologies and methods. Designers often tend to devise strategies based on the technology and processes they are used to, avoiding others that may be more appropriate for the target and preventing the deployment of innovation. On contrary, SDM broaden the standpoints and strategies designers may follow. Although firstly this freedom will require an extra effort to establish the pathways in designing activity, lately it will enable the compliance with the demands of the users.

- SDMs enable the continuous formative evaluation of the designs. Scenarios are multifarious design objects that can describe designs at multiple levels and with respect to multiple perspectives. In this way they can help designers reflect on several aspects (e.g. how people do things, the technology supporting their actions, motivations, intentions, reactions, satisfaction, etc.) of a problem situation simultaneously. The human mind is adept at overloading meaning in narrative structures and scenarios are somehow ‘stories’.

The concrete and work-oriented nature of scenarios makes them an effective representation for our design purposes, Scenarios can be quickly deployed, shared, understood, and refined; they are easily improved with sketches, scripts or other mock-ups. Scenarios serve as a central representation throughout the development cycle, first describing the goals and concerns of current use, and then being successively transformed and refined through an iterative design and evaluation process. The following figure depicts the three main stages of any scenario-based design method.

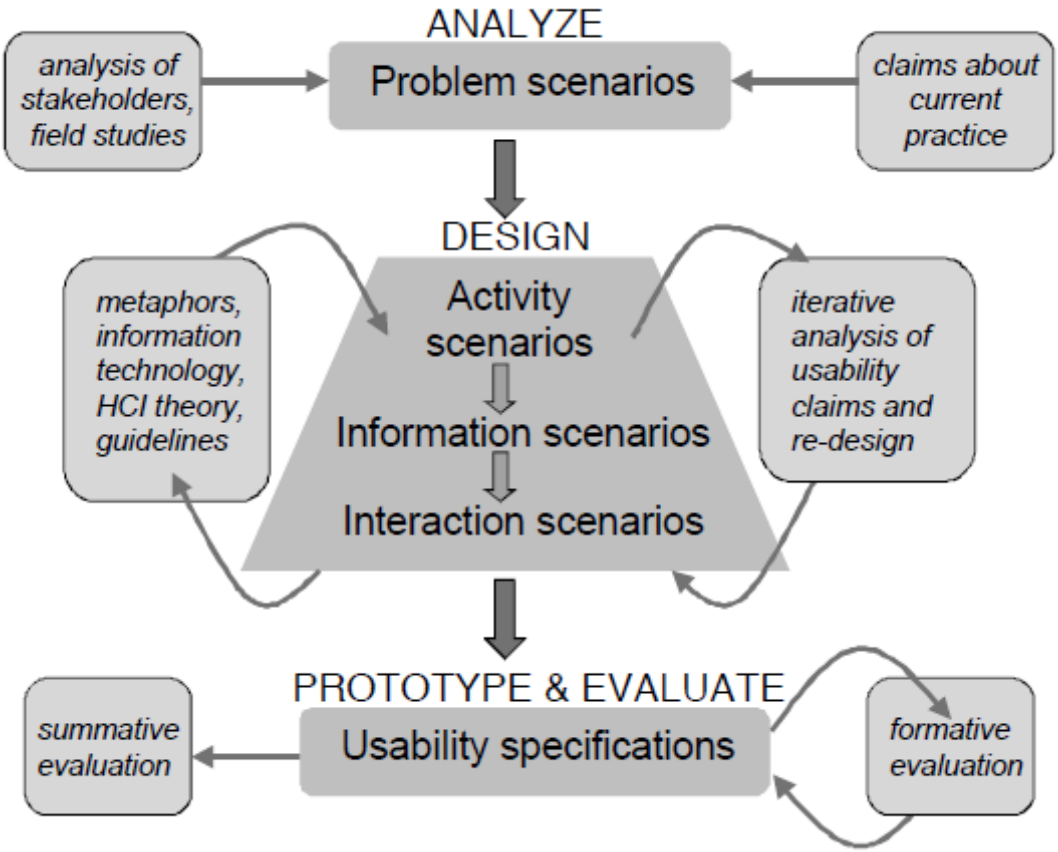


Figure 1 Scenario-based Design Method (Rosson, 2002)

2.1 Methods for the analysis of the context

The first step in every SDM is the identification of the different scenarios present. The initial analysis of the framework and context of the system and the stakeholders that will get in touch with the platform will lead to the problem scenario**.** At this stage a **comprehensive qualitative analysis** of the environment of application should be carried out. It will provide designer with the building blocks for the next stage: scenario engineering and building. Those scenarios will drive the rest of the design process and will constitute the base for iterative evaluation.

2.2 Methods for the design of the health information system

2.2.1 Scenario building

After the definition of stakeholders, it is possible to build three different kinds of scenarios:

- **Activity scenarios** describe the meaningful activities stakeholders may perform using the design system, and the set of new activities that are achievable arising from each action, expanding the 'design space'. It tells the

story, through metaphors, of one user or 'persona' within the system. Thus it is a creative process that draws for a starting point (including context and goals) and follows heuristic pathways, enhancing positive outcomes and minimizing the negatives. Personas are fictional characters that we create, and they serve as archetypes or as reminders of who our users are. We must define their role within the system, but also their motivations, capacities and goals. (Costa, 2011).

- **Information scenarios** describe the sets of data for the system and how it would be managed. It includes data models, and health information pathways. Moreover, it describes how information would be organised, rendered, retrieved, updated, etc. during user's activities.

- **Interaction Scenarios** describe how users would get outputs from and produce inputs to the information system. Moreover it tells how information is presented to users, and how they navigate into the information system

2.3 Methods for usability evaluation

As already stated, one of the main goals of scenario-based design methods is the development of a usable product, that meet the requirements of the final user. Thus, the usability of every information system must be inquired along and after the design process. There are two kinds of evaluation strategies: Formative and Summative evaluation.

2.3.1 Formative Evaluation

Formative evaluation is carried out during the design process. The aim of this group of evaluation technique is the on-going assessment of usability. It provides designers with continuous feedback and helps them identify the strength and weaknesses of the devised design, and whether and how they should modify the way in which they are working. Users can be included in discussion and devising of activity scenarios and their feedback may be obtained in informal settings (e.g. participatory design sessions). Besides, analytic reviews such as usability inspections or cognitive walkthroughs yield formative evaluation feedback that guides changes and expansion of the design vision

2.3.2 Summative Evaluation

Summative evaluation is carried out near the end of the development cycle or design stages. It aims to assess how well the system performs with respect to its initial arising usability specifications and to those arising during development. In this case the final design or product is presented to the user in the form of mock-ups or prototypes. Then some standardized usability questionnaires and scales are passed in order to obtain a 'quantitative approximation' of usability and user perception on the system that allows the final validation.

2.4 Methodological approach for the Bachelor Thesis

2.4.1 Analysis of the context: Case Study Research

The analysis was performed following **case study research**, which focuses on the holistic understanding of the dynamics present in a management situation (Eisenhardt 1989). Thus, I conducted a deductive analysis based on 7 dimensions identified by the European Commission as crucial factors for the evaluation of Integrated Care initiatives. (Villalba, 2013)

The primary subject of analysis were the different units of the Geriatrics Service at the Hospital Universitario de Getafe, meanwhile the professionals of each of these Units were the secondary subjects. Data was gathered from the Service through direct observation, an exhaustive documentation review and dedicated interviews with the different stakeholders in the service.

2.4.1.1 Direct Observation

I performed the direct observation by visiting all the facilities and different Units in the Geriatrics Service. During this stage I had the opportunity to monitor the different problem sources for the Integrated Model and devise the initial sketch of the requirements of an efficient health information system. Apart, it was the cornerstone for the rest of the analysis. I build the interviews keeping in mind the information I could get and planned the strategies for documentation. Moreover it was also the first contact with the regular processes established in assessment, treatment and management of the elderly and their diseases. I heard about some concepts that were crucial in latter stages such as frailty, integration, functional assessment, etc. In fact, I had the opportunity to witness how the Comprehensive Geriatrics Assessment is carried out and how professionals integrate the disease management process. Finally I could also know at first hand the sets of data each Unit manages and the usual information pathways within the Hospital and with external agents in healthcare.

2.4.1.2 Documentation and literature revision

After the observation stage I started searching information sources for the description of the context of the Geriatrics Service, the state-of-the-art of Health Information Systems and the motivations for integration and efficiency in the management of elderly patients. I employed both academic literature (papers, books, etc.) and grey literature from different sources (hospital internal data, repositories, manuals and not published articles, etc.). Thanks to the revision of all these materials I learned on the methods followed by other researchers for the analysis of integrated care programs or models, the dimensions they use in the analysis and the factors they take into account. Finally I adapted these methods and factors to suit the particular features of my study.

2.4.1.3 Semi-structured interviews

In parallel to the documentation activity I carried out a series of interviews with the direct stakeholders in the integrated care program. The selection of the stakeholders was performed taking into account who were the final users. The interviewees were the main deviser and promoter of the integrated care program at the Geriatrics Service, meanwhile the rest are the main actors who enable its proper functioning and foster integration. I contacted the interviewees, got their agreement, and designed and conducted the interviews. In total I conducted 6 interviews.

The goal of such interviews was to get the standpoint and inputs for the design from the interviewees, and to understand how and why they come to have this particular perspective. In this sense, the qualitative research interviews had the following characteristics: a low degree of structure imposed by the interviewer; a preponderance of open questions; a focus of 'specific situations and action sequences in the world of the interviewee' rather than abstractions and general opinions. The interviewee was treated as a 'participant' in the research, actively shaping the course of the interview rather than passively responding to the interviewer's questions. I used semi-structured interviews, as they involved even more the interviewees who had the chance to give weight to the most pressing needs and most desired improvements. The interview structure aimed to empower and engage users in the model design process (Stuckey, 2013).

Interviewee	Position
Dr. Leocadio Rodríguez Mañas	Head of the Geriatrics Service at the University Hospital of Getafe
Dr. Roberto Petidier Torregrossa	Staff Geriatrician at the University Hospital of Getafe. In charge of the Community Care Unit
Dr. Cristina Alonso Bouzón	Staff Geriatrician at the University Hospital of Getafe. In charge of the Falls and Fractures Unit
Mrs. Nuria García Grossocordón	Staff Occupational Therapist of University Hospital of Getafe
Dr. Julia Illan	Staff Geriatrician at the University Hospital of Getafe. In charge of the Orthogeriatrics Unit
Mrs. Ascensión Sáiz Ruiz	Head of the IT Department at University Hospital of

Table 1 Interviewees' profiles

The structure of the interviews comprised some pre-established blocks. Although questions were tailored according to interviewee profiles and new topics and insights arose during the development of interviews, these blocks provided myself with a mental sketch of the topics that should be covered in the case study.

Block 1	General aspects on role in the Geriatrics Service
Block 2	Contribution to integration
Block 3	Barriers for integration
Block 4	Current information management
Block 5	Possible improvements for the system
Block 6	User interaction

Table 2 Structure of the Interviews for the Case Study

Finally, the three components of the case study were merged, and the comprehensive analysis of every item led to the development of **scenarios**, which were later the core elements for the **design of the prototype** of the Health Information System.

2.4.2 Design of Scenarios

Three different kinds of scenarios were built with the information from case study research. First it was important to know who the stakeholders are. In this case the definition of users is straightforward after the direct observation of the Geriatrics Service:

a) Geriatricians serving in the Geriatrics Service

b) Specialists from other services in the hospital.

c) GPs from primary care.

d) Occupational Therapists

e) All kind of nurses in contact with patients in the integrated care program, including those working in the Geriatric Service, in other services in the hospital and in nursing homes in the community.

f) Administrative staff in the Geriatrics Service who appoint patients and manage bureaucratic issues.

I decided to choose an idealized specialist from the Geriatrics Service as my persona in the scenario, as they would be the users in with more relevance in the care model. Once my persona was defined I started building scenarios. I followed an iterative strategy: the outcomes of Formative evaluation became the feedback for improvement. Subsequent versions were delivered to physicians in the service and my colleagues at the Research Foundation; and continuously refined, until the final version was developed and validated. I built the information scenario after the careful revision of the main parameters in each Unit at the Geriatrics Service and the identification of other variables that may also be suitable to be included in the new HIS. Moreover I analysed the main information pathways and interfaces among different units in the Service and with the general Hospital de Getafe HIS. The human-computer interaction model and the navigation map were also evaluated along the development. I asked users to describe how they would like to retrieve and deliver information and move through the system. New functionalities appeared after each feedback loop.

2.4.3 Evaluation

2.4.3.1 Formative evaluation: Informal meetings and heuristic assessment

In order to tackle formative evaluation, I employed two assessment methods that were iteratively implemented during the designing process.

- First, I held periodic meetings with different specialists from the Geriatrics Service, who kindly supported me along the whole process, until the final scenarios were built.
- Apart, once data models and required functionalities were derived from the analysis I suggested them real-life situations to know how they would navigate through the system. I asked them to sketch on paper how they would move through the system in order to perform pre-defined tasks. This heuristic approach provided me with a broader knowledge on professionals' capacities and desires, which was crucial for the development of scenarios and prototype.

2.4.3.2 Summative Evaluation: usability and user experience surveys

Moreover, summative evaluation was carried out at the end of the process. Therefore I could reach the conceptual validation of our prototype, so it may be used as a model for further development. 4 professionals from either the Geriatrics Service or the Research Foundation were asked during some final meetings to have a look at the key-pathways in the information architecture of the system and the user interaction model and provide some feedback. They were presented a mock-up of the user interaction prototype created with the **Justinmind prototype** software.

Professionals	Position	Gender	Age
Dr Marta Castro Rodríguez	Staff Geriatrician at HUG. Head of the Outpatient clinic.	Female	40
Dr Jimmy Gonzales Turín	Staff Geriatrician at HUG. Acute Care Unit and Outpatient Clinic	Male	36
Dr Marta Checa López	Staff Geriatrician at HUG. Acute Care Unit	Female	34
Dr. Olga Laosa Zafra	Clinical pharmacologist at the Biomedical Research Foundation	Female	42

Table 3 Professionals include in the summative evaluation of the prototype

In the interviews, two different questionnaires/scales were employed to assess the perception of final users in the system:

- **System Usability Scale (SUS):** This scale is based in 10 Likert items that cover different usability concerns: effectiveness of the system, efficiency of effort and resources and user satisfaction. Users must range in a 1 (Strongly Disagree) to 5 (Strongly Agree) scale each item. Although the scale seems to be easy and simple, interpreting the results implies further steps. These have been standardized to enable the comparison of different systems. The steps are the following.

    1. For odd items: subtract one from the user response. For even-numbered items: subtract the user responses from 5. This scales all values from 0 to 4.
    2. Add up the converted responses for each user and multiply that total by 2.5. This converts the range of possible values from 0 to 100 instead of from 0 to 40

    The output value after this transformation is the one that may validate the usability of your system. It is not a percentage, so should not be studied under that standpoint. Contrarily, it may be better analysed it making comparisons with other systems, and ranging in terms of percentiles. Nevertheless, a score of 68 has been established as a reference for the average and the criterion to validate usability.

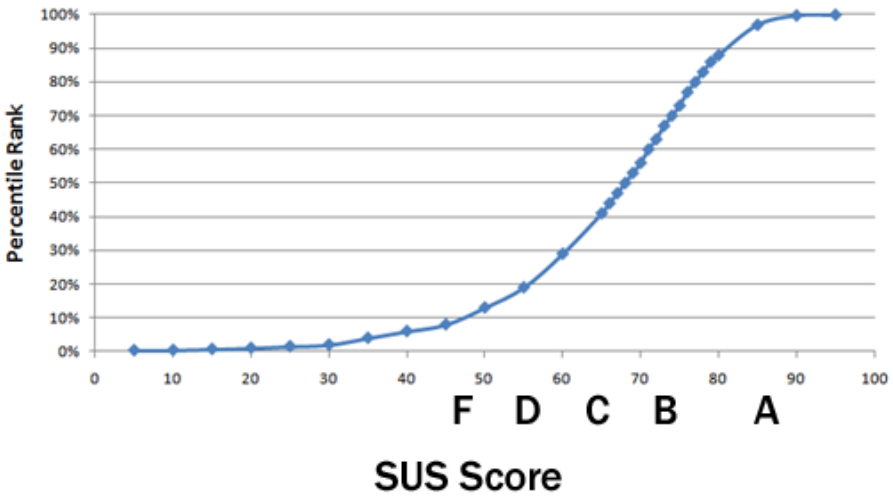


Figure 2 SUS score and percentile grading

- **User Experience Questionnaire (UEQ)** allows a quick assessment of the user experience of interactive products. It inquires the feelings, impressions, and attitudes of users that arise when they use a product, both in pragmatic and hedonic sense. The main dimensions considered are:
  - Attractiveness: Overall impression of the product. Do users like or dislike is?
  - Perspicuity: Is it easy to get familiar with the product?
  - Efficiency: Can users solve their tasks with the product without unnecessary effort?
  - Dependability: Does the user feel in control of the interaction?
  - Stimulation: Is it exciting and motivating to use the product?
  - Novelty: Is the product innovative and creative?

Although each dimension has the same weight in the final result, the conceptual scheme that has triggered their development follows a hierarchical structure, depicted in the next figure:

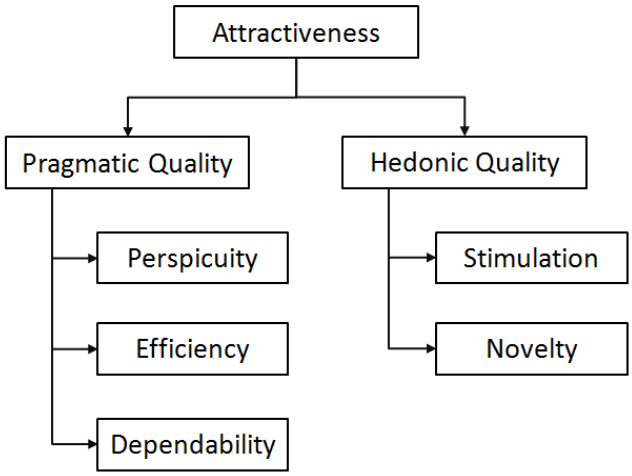


Figure 3 Dependency of the UEQ scale (Rauschenberger, 2013)

Each item in the questionnaire is associated to one of these dimensions, which become somehow 'categories'. Users must range their agreement with either one of two opposite terms (e.g. clear vs confusing), in a scale from 0 (completely agree with term 1) to 7 (completely agree with term 2).

Then, the answers are ranged from -3 to +3 (keeping the 7 possible values) and an average value is computed for each of these dimensions or categories. Extreme values are often avoided by users when they take the questionnaire, so values below -2 or above +2 are not recurrent. Values above 1 are considered to be good, while values below -1 are bad. (Rauschenberger, 2013)

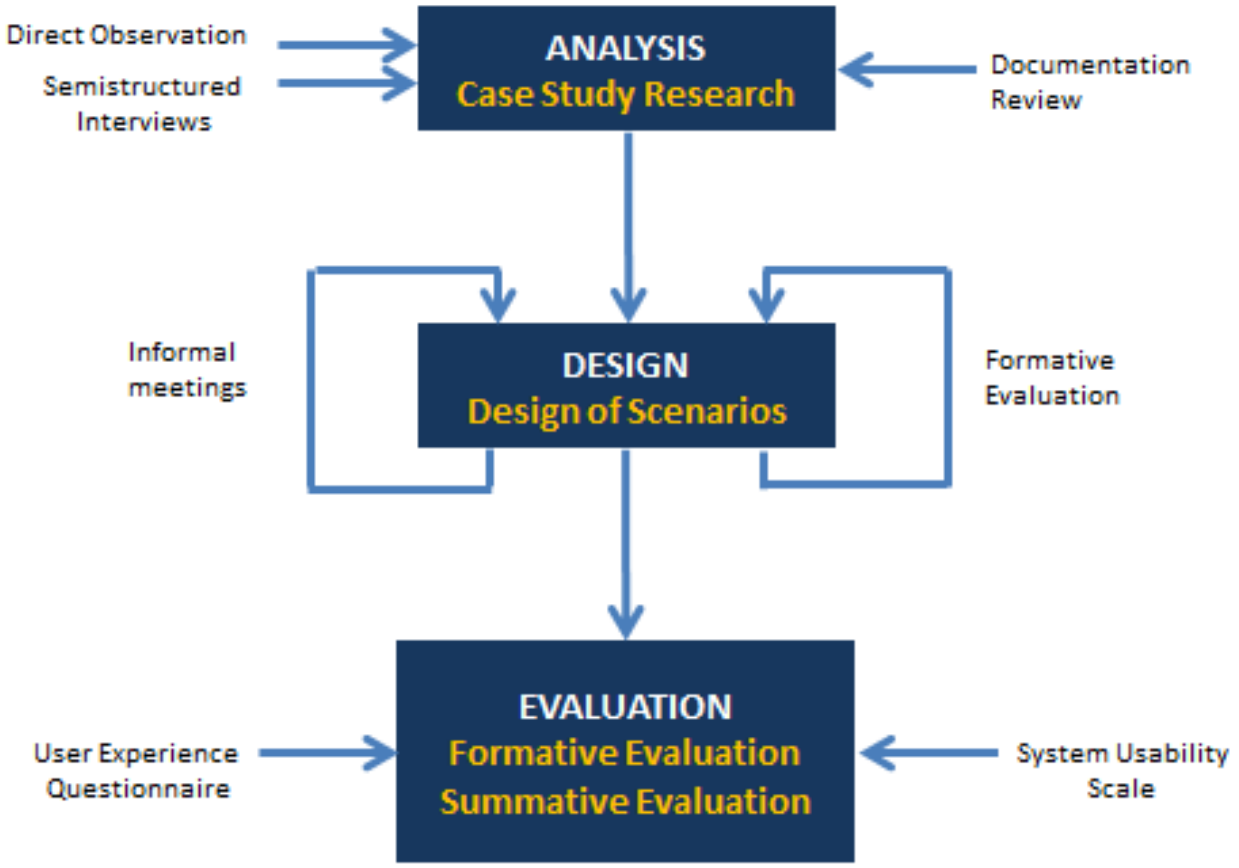


Figure 4 Methodological approach for the bachelor thesis

3 Background: Integrated Care and Health Information Systems

Integrated Care is one of the most promising approaches to solve the economic unbalance and the low efficiency monitored in some public welfare systems. Although specialists have not agreed a formal definition for 'integrated care', the word 'integration' which derives from the Greek term 'integer' (complete) links health care with a holistic standpoint. This new perspective may be applied to the way we think about, shape, deliver, manage, organize, regulate, finance, and evaluate public healthcare. The main motivation for this paradigm is the size and complexity healthcare systems have reached which often interferes with the maintenance of quality standards, cost effectiveness and efficiency. Integrated care can be the comprehensive framework to develop better and more cost-effective healthcare networks, to avoid fails or delays in service provision and to keep up patient satisfaction indices. This comprehensiveness implies the full understanding and knowledge of the system, all its constituents and the relationships among them. On the one hand, these relationships are intended to be complementary and prevent tasks overlapping. On the other hand the definition of responsibilities should not leave uncovered gaps in service. The pursuit of the equilibrium between the avoidance of overlapping and the achievement of complete service must be the main goal of healthcare systems designers. Integrated care may be the glue they use for the seamless join of all components (Kodner, 2002).

There are different causes that led to the unbalance of health care systems in developed countries (Europe, North America, Japan, etc…), both in economic and organisational terms. Most of them arise from the fast economic and social changes humankind has experienced in the last two centuries which have also impacted medical science and life habits. Currently there are mainly two sources of factors that foster integrated care. First, patients (users) pose challenges for healthcare systems. Populations are plastic and their requirements are continuously changing and healthcare managers must re-engineer systems to adapt and to meet these changing needs. In addition, supplier organisations also find motivation for integration: the increasing reliability and acceptance of technology in the management of patients and the potential benefits for the reduction of economic pressure on systems are encouraging their managers to adopt efficient integrated paradigms.

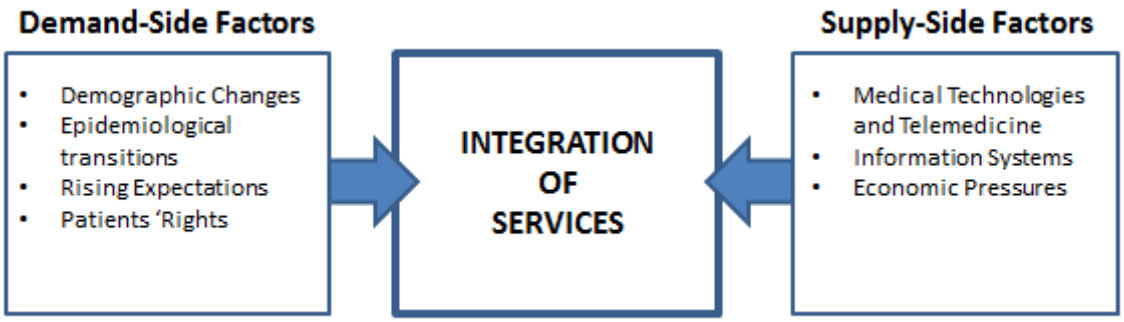


Figure 5 Driving forces for Integrated Care (Gröne, 2001)

In the following paragraphs I analyse the main historical and socioeconomic events that have culminated in the current public healthcare systems, their features and how integration may improve their performance.

3.1 History, development and features of public healthcare systems

Until the 18th century health care delivery in Europe was based on the ambulatory service to wealthy patients by General Practitioners and the assistance of low-income people at hospital facilities managed either by the Church or other charity and philanthropic institutions. So far, governments had just promoted public health services during the rise of epidemics and plagues in Middle Ages cities. These services were temporary and targeted the prevention of spread more than the recovery of affected citizens. Nevertheless, the emergence of new ideas during the Enlightenment, the Universal Declaration of Human Rights, and social changes after the Industrial Revolution changed the standpoint about the right for healthcare services, as one of the pillars of Modern State. Besides, the rise of ideas such as Communism, Socialism and the creation of trade unions triggered the establishment of the first healthcare proto-systems and the coverage of almost the whole population. This environment was the breeding ground for the creation of public healthcare systems and their standardization in either one of the two main models: Beveridge and Bismarck (Porter, 1999). Beveridge Model, established by the British economist William Beveridge in its report 'Social Insurance and Allied Services' in 1942, is based on the contribution of all people in working age to a National benefits plans for unemployed, sick, widowed or retired people. In Beveridge model care is operated by a single public institution. For instance, in the United Kingdom, the Labour party Government founded the National Health System (NHS) in 1948, following Beveridge's guidelines (Gorsky, 2008). Contrarily, the Bismarck model guarantees health care by the insurance by many different non-profit public sickness funds. In some countries like Austria patients are allocated in one of these health maintenance organisations depending on their job, hometown or other conditions. Besides, other countries as Israel or Germany allow patients to choose the public sickness fund they want to join. The Bismarck model was named after the Chancellor Otto von Bismarck who implemented it in the 19th century in the unified Germany. Initially the Insurance was guaranteed only for contributors or active working force. Nevertheless the model has evolved and currently Bismarck-based health systems in many countries target the whole population (Kutzin, 2011).

Second, advanced medical knowledge has brought intricacy to public healthcare systems. The milestones achieved in all sciences, the development of technical tools and the incorporation of computing systems to biomedical research have enabled crucial discoveries in different fields such as Molecular and Cell Biology, Anatomy, Physiology, Pathology, Pathophysiology, Immunology, Quantum Physics, Biomechanics, Genetics, Electronics, etc. These breakthroughs have widened the basic knowledge on how human body evolves along life and how it behaves in normal and pathological conditions. Moreover they have brought new procedures and techniques to prevent, diagnose, treat and overcome diseases, syndromes, illness or disorders. The vast knowledge on specific systems in human body and the diseases affecting each of them required the specialization of medical professionals. Instead of the 'multitask' doctor from 18th century, different medical specialized roles arose to translate the knowledge on specific medical fields to clinical practice:

cardiologists, psychiatrists, gynaecologists, paediatricians, specialized nurses, etc. Besides, specialization also responded to health administrative rationality and common sense: large populations may be better managed by the proper classification of patients. Clustering patients with similar characteristics and referring them to specialized staff promotes time, effort and resource efficiency (Weisz, 2003). Moreover, the management of diagnosing tools or complex therapeutic techniques such as medical imaging or radiotherapy have engaged new specialists, technicians and professionals to medical environment (x-ray technicians, engineers, physicists, etc.) Finally, current healthcare systems employ not only physicians and nurses, but a wide range of non-medical professionals, including different kinds of scientists and other profiles devoted to administrative, operational and organisational activities.

The expansion of public healthcare organisations, the development of medical specialities and the pursuit of universal coverage have led to a complex environment for the establishment of welfare systems. This has increased functional and structural differentiation and healthcare managers have settled as intricate networks. These meshes include different care facilities, both in- and out-patient: national and regional reference hospitals, speciality reference hospitals, province hospital, ambulatory care facilities, nursing homes, etc. Moreover there are different care levels depending on the technical demands of care procedures and the degree of specialization of the medical professional involved: Primary care, Secondary care, Tertiary care and Quaternary care level (Starfield, 1998).Therefore healthcare provision and professional responsibility are currently fragmented and quality of delivery may be compromised and duplications, gaps or inconsistencies may arise (Axelsson, 2006). Although every system has its own particular features, all of them require a regulatory environment to define the efficient allocation of resources and workforce. This definition is usually modified after the outcomes of cost-minimisation, cost-benefit, cost-utility and cost-effectiveness analyses (Sutton, 1997). Moreover, communication among all care providers is crucial for the proper functioning of the system. Finally, the large and dispersed character of these systems demands the definition of criteria for the allocation of patients, for their eligibility for services and for the clinical pathway they will follow within the system. Otherwise, the system might become inefficient and duplicities, fails in provision or inadequate procedures night arise. Finally, the standardization of those clinical pathways reduces the variability of health care provision and brings efficiency and optimization (Panella, 2003). Health Information Systems are crucial to enable the definition of those pathways and inclusion/exclusion criteria, as they allow professionals to manage data and information in a faster, reliable and comfortable way.

3.2 New demographic challenges in healthcare

The development of medical science, the access to medical service for general population and changes in life habits have increased steadily life expectancy in developed regions (OECD, 2013), while new social models and the inclusion of women in labour market has decreased fertility remarkably since 1970. (OECD, 2014)

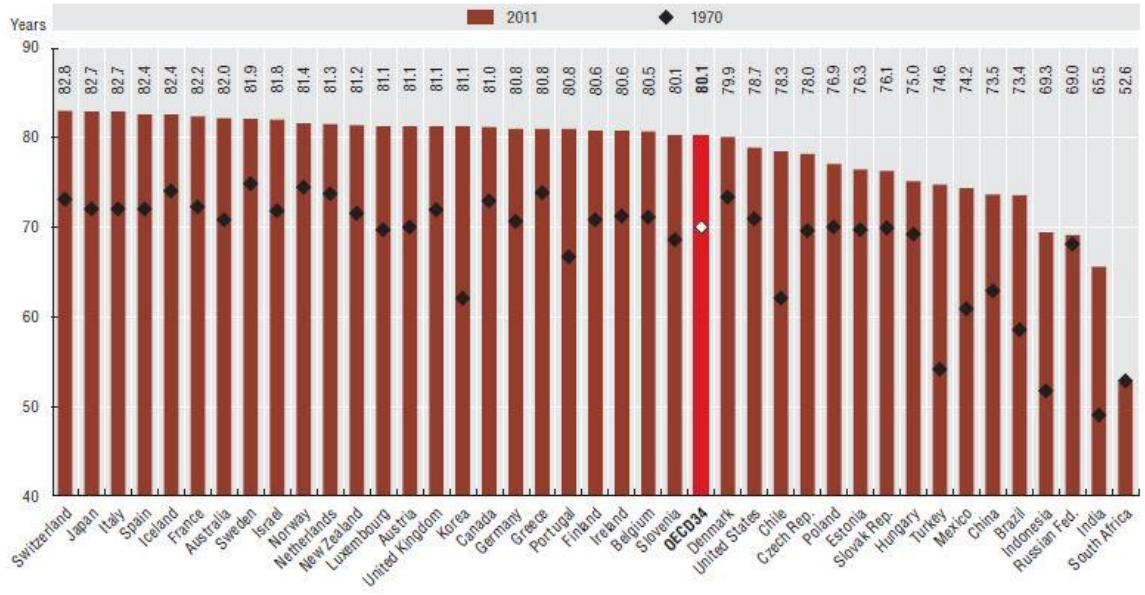


Figure 6: Life expectancy in 1970 and 2011 (OECD Health Statistics 2013, World Bank for non-OECD countries)

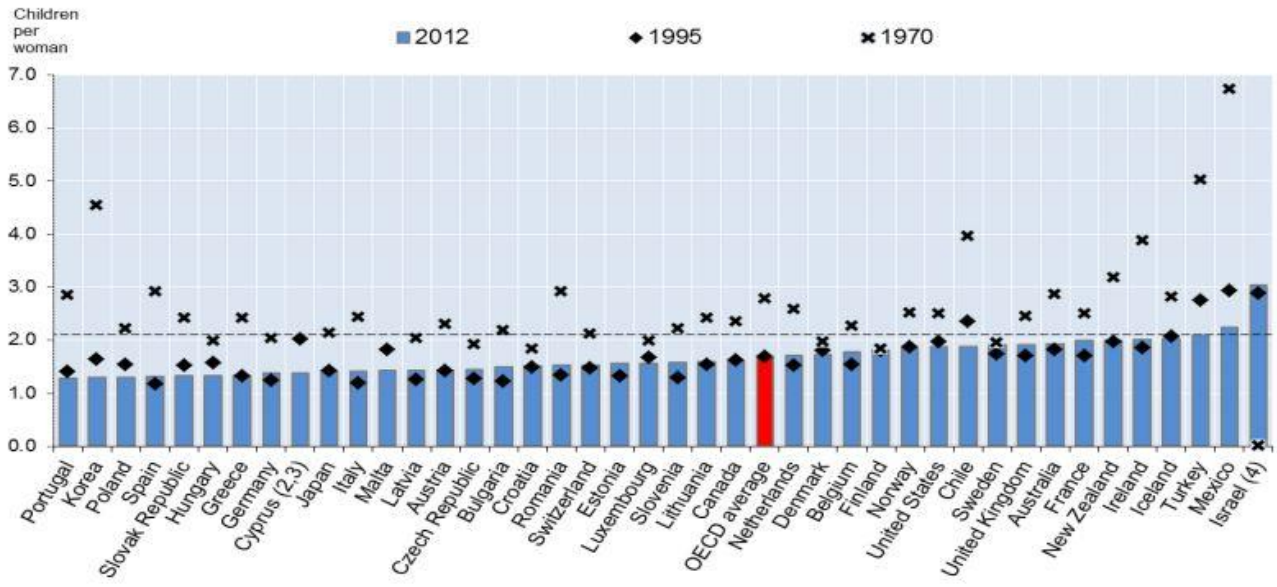


Figure 7 Fertility rate evolution (National Statistical Offices, 2014. Eurostat Demographic Statistics, 2014)

These two trends are promoting ageing population, increasing the percentage of people aged over 60. This indicator is expected to grow in high-income countries. For instance, in Spain it would increase from 23.1% to 40.2% in 2050 (United Nations, 2013). Thus, the demands of healthcare users and the patterns of morbidity are changing. Older patients often present multiple disorders with functional, psychological and social dimensions that may be better faced by integrated forms of health and social service provision, both in quality of service and economic terms. Chronic diseases (e.g. heart disease, cardiovascular disease, cognitive impairment, diabetes mellitus, cancer, falls syndrome REF, etc.) require care

continuum and much more complex forms of treatment than the one provided in hospital facilities and their assessment and service should include Primary, Secondary and Tertiary care (Gröne, 2001). Therefore, integration should be devised in this sense. Finally, elderly people do not contribute to public healthcare systems as they do not belong to the workforce. On contrary they are 'big users' of medical and social services due to their chronic, complex and in many cases disabling conditions, becoming a burden for the equilibrium of healthcare systems and a big challenge for their managers (Zweifel, 1999).

Besides, governments in many countries are reducing the resources available for healthcare issues due to the current economic environment. Particularly, Spain has been remarkably hit by the economic crisis. The unemployment rate has risen to 25% of labour force and the GDP has dropped by approximately 6% from 2008 to 2015. In this regard, the Troika recommended Spain, among other countries to cut their resources for workforce, administrative issues and services in different fields such as health and social care, education, pensions, etc. This mandates impacted the public health expenditure in the country, which has fallen by 4% respectively from €70,848,000 in 2008 to €68,607,000 in 2012 .This reduction of the investment in healthcare issues has not impacted private health expenditure in the same vein, as it has increased by 3.12% from €26,244,000 to €27,064,000 in the same period. (Ministerio de Sanidad, Servicios Sociales e Igualdad. Gobierno de España, 2014). Spain is not a unique case, and other countries in Southern Europe (Greece, Portugal, etc.) are following similar policies (Karanikolos, 2013).

These two phenomena are triggering an economic unbalance in welfare systems and therefore compromising healthcare standards and quality of service. Some governments are establishing out-of-pocket payments and drug co-pay by patients as a possible solution for the situation. Nevertheless, integrated care seems to be a superior and more promising approach, as it does not imply the use of extra resources, but the better use of them.

The definition of 'integrated care' and the motivations to implement it are clear. The following step is the identification of the characteristics of integrated systems, the different types of integration and actions that lead to them and the considerations healthcare managers and policy makers should keep in mind while devising integrated care strategies.

3.3 Types of Integration

First, the complex hierarchical structure of healthcare systems enables integration in two different dimensions: Vertical integration occurs between organisations or organisational units of different levels (e.g. between Primary Care and Secondary care). Apart, horizontal integration takes place between organisations at the same level (e.g. between two specialized care units). These two integration approaches are present and combined in healthcare systems and define the type of relationship among organisations and providers: coordination, collaboration, cooperation and contracting. These concepts are often referred indistinctly as they describe the same situation: different organisations working with shared goals. However they have different connotations in terms of leadership and organisational arrangement. Next figure

presents a conceptual scheme of the breadth of each component (vertical and horizontal) in the different forms of integration:

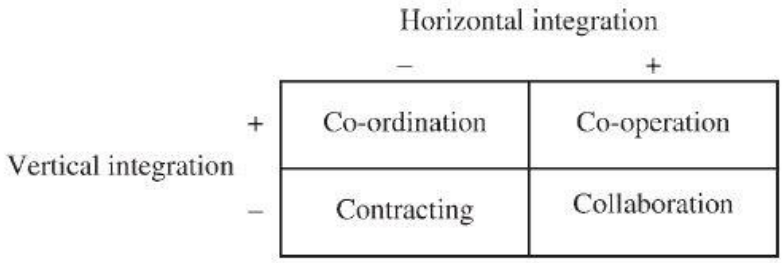


Figure 8 Conceptual Scheme of Integration models. (Axelsson, 2006)

Thus, co-ordination is the integration of components belonging to different levels in the structure, where the top one is the source of ideas and commands. Contrarily, collaboration aligns the strategies of elements at the same level and none of them has preponderance over the rest. Co-operation implies both vertical and horizontal integration: organisations or elements of the system integrate at their level and with others above and below. Finally, organisations can work together without integration through contracting (Axelsson, 2006). The desire result would be to reach deep co-operation among all healthcare providers, although complete integration is ideal.

3.4 Key facilitators and actions for integration

The processes and actions leading to integration must be carefully performed to guarantee the transition from pilot to the final implementation of integrated care models as regular strategies in clinical activity. These process is A comprehensive analysis of the environment and the system must be performed before implementation to reach success and go beyond piloting stages. This analysis may lead to the main facilitators and barriers for the deployment of the Integrated Care solutions in particular environments, systems and facilities. Barriers are those factors that inhibit an effective and efficient development of integrated systems, while facilitators are the motivating factors for it. Obviously these two sets of factors must be taken into account for integration, although facilitators seem to be more relevant for the final implementation, as when present, they help overcome any barrier that arises (Villalba, 2013). Health policy makers should create an appropriate environment for the engineering, implementation and scaling-up of integrating initiatives and somehow bring those facilitators in the breeding ground for the new actions. The European Commission is specially committed to the identification of these factors as a first step for the development of joint policies that enhance quality and efficiency in health care provision in the EU28 countries. They have carried out several studies in this sense, and have stated eight facilitators for the deployment of Integrated Personal Health Systems (IPHS) in the European environment. The following table depicts these factors:

Name	Description
Reorganisation of services	Cooperation between tiers of care, and health and social care organisations enabling the care continuum and access to service from multiple points of access. (e.g. home care)
Patient focus	Patient-centred philosophy, focusing on patient's needs. Initiatives to get patient engagement and participation. (e.g. patient portals)
Governance mechanisms	Inter-professional teams across the continuum of care. A legal framework for liability issues. Strong, focused, diverse governance represented by all stakeholders. Organisational structure that promotes coordination across settings and levels of care. (e.g. protocols defining responsibilities and tasks allocation for multidisciplinary teams)
Interoperable information systems	Interoperable information systems to collect, track and report information and activities; and to enhance communication and information flow across the continuum of care.
Policy Commitment	Organisational support with demonstration of commitments. Policy leaders may instil a cohesive culture enabling the care continuum. (e.g. regulation of integrating actions)
Engaged Professionals	Engage professionals in a leading role. (e.g. educational programs, empowerment)
National investments and funding program	Sufficient investments and funding to ensure adequate resources for sustainable change and up-front costs.
Incentives and financing	Service funding and incentives alignment to ensure equitable distribution for different services or level of services. Funding mechanisms must promote interprofessional teamwork.

Table 4 Facilitators for IPHS deployment in Europe (Villalba 2013)

3.4.1 Reorganisation of Services

Integration is built through new processes and organisational structures. The empowerment of healthcare organisations with competences to modify their systems, launch and test models in pilots, and implement initiatives is essential for success. This **reorganisation of the services** must promote the coordination of all core services across the continuum of care and enhance the accessibility of patients to service. In this sense, managers should de allocation of healthcare delivery points regarding the demographical characteristics of their population and the real requirements of each service. For instance, the reform carried out by Kizer's in the American Veterans Health Administration (the Federal body for the provision of health and social care to US Amy veterans) provoked the externalization of care services from hospitals to ambulatory facilities. One the one hand, this transition required the investment of extra resources in technology, to enable the coordination of different agents at different facilities. On the other hand it reduced the expenditure in bed days which was onerous and unevenly allocated (Mansoa, 2015).

3.4.2 Patient-centeredness

The establishment of patients at a core position in the system is related to the maintenance of quality standards and efficiency. Their commitment is crucial for the inclusion of technology in healthcare and for the pursuit of the most appropriate Disease Management Processes (DMP). Hence, the healthcare systems must target patients' real needs to guarantee the best outcomes both in economic and clinical terms. The new **patient-centred** approaches must enhance the perception of patients on the system, make them feel supported and motivate them to play an active role in the model. For instance Maccabi Healthcare Services, one of the 4 public Health Maintenance Organisations in the Israeli public healthcare system has established a technological Call Center for the remote assistance and more dedicated support of chronic patients. Maccabi has empowered its users to choose the most comfortable communication pathways so they can contact multidisciplinary teams at the Call Center at any time either by phone calls, teleconference, on a dedicated web portal or at kiosks in their facilities. They have proved the positive impact of the new approach on patients' and caregivers' psychological status, and on their perception and compliance to new care models that require less resources and guarantee quality standards (Peinado, 2015b).

3.4.3 Governance Mechanisms

'**Governance mechanisms** stand for the joint action of health and non-health sectors, of public and private actors, and of citizens towards a common interest' (Villalba, 2013). Integrated care initiatives must find the commitment and support from many different agents. Managers must trigger the suitable processes to reorganize care and promote collaboration (creation of new roles, definition of responsibilities, formation of multidisciplinary teams, etc.) Moreover, they must sign contracts to define the allocation of tasks between partnering organisations and to guarantee complete covering and continuum of care. Finally, new care processes and positions within the system require the statement of new and dedicated liability regulatory environments.

3.4.4 Incentive Programs and professional engagement

Professionals must understand their role within the system, cooperate and align their efforts with those of the organisations to foster integration. Although initiatives are usually devised by managers, professional engagement is key to mainstreaming integrated models. In some cases, especially in those that include independent actors, the compliance to the joint strategy must be enhanced by the development of some **incentive programs**. Fee-for-performance seems to have the best effect on the deployment of integrated care rather than capitation or fee-for-service. An example of this win-win relationship is the strategy by Maccabi Healthcare Services ensured the compliance of independent GPs by contracts that regulated their commitment to the use of Maccabi's EMR in return to some economic incentives like interest-free loans for the purchase of equipment (Peinado, 2015b). Contrarily, Veterans Health Administration (VHA) is a good example of how poor innovation incentive can hamper new actions. Its managers have the power to operate it freely and they account on vast resources, so it would be the perfect breeding ground for integration. They are aware of the need for the application of telehealth solutions, especially due to the large rural population they manage, and are willing to dedicate funds for such purpose. These freedom and values are transmitted to all management levels and local medical leaders would launch projects and initiatives. However, the funding model of VHA is annual and based on economic results from the last year. Ultimately this is a constraint for innovation. If a medical centre shows improved economic outcomes thanks to some innovative action, the system automatically decreases their budget. This way, efforts for innovation are not acknowledged but contrarily they are indirectly aggrieved (Mansoa, 2015)

3.4.5 Policy commitment

The legal environment of the target regions or countries can determine the breadth of achievable integration and the chances for the expansion of integrated care models. Law may either hinder the modification of traditional care service structure or even impede it. The background of some countries (e.g. Denmark, Austria) in which pilot projects have proved the economic benefits of integrated care models has got the **commitment of policy makers** who have elaborated and passed Laws to facilitate mainstreaming of integrated care at national level. For instance, Austrian parliament passed in 2005 a Health Reform Act that regulated the application of telemedicine solutions (one of the most promising integrated care approaches). This legal framework empowered and encouraged the health insurance company VAEB to launch Diabmemory, a mHealth system for monitoring Diabetes Mellitus Type 2 patients which has improved the management of the disease (Peinado, 2015a). Other governments (e.g. Spain) are not so aware of the need for integration and have not promoted it. Thus, integrated care models, although successful have not overcome the limits of the regions where they emerged (e.g. Telemonitoring in the Basque Country).

3.4.6 National and regional funding programs

The application of telemedicine and personalized healthcare services require the investment of extra resources, especially in the first stages of implementation. These incomes are employed for financing pilot projects and research, the purchase

of technology, incentive programs for professionals, education for patients and caregivers, etc. and may be obtained by alternative means such as the application for national and supranational innovation-funding calls, the participation in European projects or the inclusion of technological partners which may be interested on the promotion of their products For instance, the company which manages public hospitals in the Austrian region of Carinthia (KABEG) performed its chronic patient tele-monitoring pilot thanks to the co-financing from the Renewing Health European project. Besides, they included in the project the telecommunications company A1 Telekom Austria which provided patients with active devices that recorded parameters, built the information network for data sharing, installed the devices at patient's homes and offered continuous technical support (Villalba, 2015a). Nevertheless, policy commitment must be aligned with dedicated **national and regional funding programs** to allow mainstreaming, the establishment of the solutions as final care standards and the expansion of the integrated care approaches.

3.4.7 Interoperable information systems

Successful coordination requires continuous and smooth communication between all actors and the availability of complete and reliable information on patients. Information and Communication Technologies (ICT) have completely shifted the communication processes and pathways. The existence of Health Information Systems (HIS) have allowed the transition from paper-based to digital information format, enabling real time information exchange and enhancing data security and reliability. Besides, the development of Electronic Medical Records (EMR) has homogenised the set of data professionals deal with and has established the first step for the transition to personalized healthcare. However, the integration of all stakeholders in the information network must be built over **interoperable information systems**. Otherwise, the inclusion of all elements may face seams that could lead to service gaps or set barriers for implementation. In that case, health information system may not become a facilitator but a barrier for integration. Interoperability must be built over markup standards specifying the encoding structure and semantics of information. In the case of healthcare **Clinical Document Architecture (CDA)** is the most widely accepted standard. It was established in 2000 by Health Level Seven International, an international community of healthcare subject matter experts and information scientists collaborating to create a framework (and related standards) for the exchange, integration, sharing, and retrieval of electronic health information. A second release was approved in 2005. It states that a clinical document must have six characteristics: Persistence, stewardship potential for authentication context, wholeness and human readability. CDA documents withstand any kind of clinical content in any format (e.g. pdf, Word, jpg.) and include a textual part (for human interpretation) and structured parts (encoded for software processing).

3.4.8 Initial comprehensive standpoint

Apart from bringing together as many facilitators as possible, healthcare managers must apply a comprehensive standpoint while targeting integrated care actions. Although complete integration would be the best possible approach for the system performance, this concept is ideal. There are many barriers than hamper the process: financing sources, legal

environment, culture readiness, literacy of patients, professional engagement, workload, technical challenges, etc. So, Healthcare administrators must evaluate the viability of integration before implementing it in terms of economic resources, features of target population, own technical capacity, readiness and commitment of professionals and patients for new care models and workforce capacity to define the most appropriate actions and the achievable degree of integration. This analysis may provide them with an overview of current and actual achievable milestones. The analysis must be carried out prior to the intervention, so the leading actors can coordinate agents involved, establish steps to follow and a solid infrastructure, and define the most appropriate processes. Furthermore it may not only help identify enabling elements but also to provide mangers with the modifiable factors that may smooth integration. For instance, some healthcare managers have modified the strategies for integration to bring over success: they have established integrated care models promoting smooth communication between patients and carers by the incorporation of Internet-based technologies (web portals, teleconferences, etc.). They overcame the low e-literacy of some patients and the barriers of access to Internet by the implementation of the communication system on phone and adapted kiosks at healthcare facilities (Peinado, 2015b). Other suitable approaches imply the exclusion of patients from the direct contact with technology. For instance some tele monitoring systems utilize active devices that send clinical parameters without the intervention of the patient (Villalba, 2015) or employ usable *Near Field Communication* (NFC) technology that uploads the information automatically to Personal Health Records (PHRs) (Peinado, 2015a) Finally, other managers have launched adjoin initiatives to reach success such as educational programmes in the first stages after recruitment to empower patients with knowledge on their disease and to get their commitment and engagement to devised strategy (Peinado, 2015a).

3.5 Health Information Systems

It is straightforward to notice that information availability and management are key aspects for the successful cooperation among professionals from different organisations and from different care levels and facilities within organisations. The sharing of patient's clinical data and undergone processes are pivotal to enable the efficient interaction of all healthcare actors, the prevention of adverse events and the right transition of patients within established healthcare pathways. The development of the Computing Science and the emergence of the Internet became the hugest milestone in the history of data management and information sharing. **Health Information Systems** (HIS hereafter) were built over those tools and have been established to meet the requirements of large and complex healthcare networks.

There are many motivations for the development of Health Information systems. The implementation of Health Information Technology has been broadly adopted thanks to the benefits associated to better information framing and sharing, which makes it more available and manageable and in turn enhances its meaning and usefulness. HIS may foster the efficiency of healthcare by (1) Improving the performance of healthcare professionals, provide them with more complete and reliable information on patients and a complete summary of processes undergone. The standardization of information exchange in Personal Health Records (PHR hereafter) guarantees reliability, shared language and thus interoperable information format; (2) Enhancing patients' safety. For instance Decision Support Systems (DSS hereafter) prevent

medical errors and the occurrence of adverse events arising from polypharmacy and comorbidities; (3) Enabling the transition from paper-based to computer-based storage. Information is better managed and easily available thanks to the advantages of Information and Communication Technologies (ICTs) (e.g. savings on floor space, security, accessibility); (4) Connecting facilities in the network. Information Systems are not constrained in one single facility and regional or even global HIS has been established; (5) Engaging patients and their caregivers in healthcare, becoming no longer an exclusively administrative or professional supportive tool. Health Information Systems enhance patients' and caregivers' knowledge and consciousness on the disease and empower them to produce continuous and first-hand feedback for professionals. This input is crucial for the success of care continuum ; (6) Facilitating the creation of databases, easing clinical and epidemiological research; (7) Supporting the inclusion of new types of data (images, molecular level information) besides alphanumeric information; (8) Enabling the steady increase of the application of technological tools such as telemedicine, tele-monitoring and point-of-care diagnosis. These systems allow the management of patients at local level without the need for referral them to specialized institutions, improving access to healthcare in rural areas where services are not easily available. Furthermore they allow the transition from hospital-based specialized care to the Community; (9) Improving the operation of the system and the delivery of appropriate services, reducing waiting times and avoiding duplicity of tests and interventions (Haux, 2006) (Gröne, 2001).

Despite the significant need for a change and the promising prospects of the application of ICT in healthcare, the inclusion of such technology has been slow and marked of obstacles and barriers (Tang, 2006) (Buntin, 2011). There are many different elements to integrate and many factors that can hinder the proper operation and success of information systems. Besides, every framework for application is specific and the system must be adapted to meet the particular needs of the organisation, the environment of operation and the purpose of the application. Therefore, a comprehensive analysis of the targeted environment must be conducted to monitor the needs, facilitators, barriers and conditioning features of the particular case. The study should not just infer the suitable technological infrastructure, but also to determine the organisational framework for IT. This framework may become the most effective way to present a clear and comprehensive understanding of such complex systems and highlight fundamental aspects of it, such as the desired relationships among professionals, the relevant information and data structure they prefer and the best strategies for the management and utilisation of information (Rippen, 2012). Otherwise, HIS might not facilitate integration but set barriers for the system performance. Information gaps or improper data structure may lead to inefficient actions, impaired service delivery and extra workload for professionals.

Summarizing, the development of any Integrated Care model and the implementation of a HIS supporting it must be performed after the comprehensive knowledge of the system, its environment and its main features In the next section of this Bachelor Thesis, I present the main hallmarks of the case of interest: the Geriatrics Service at the University Hospital of Getafe.

4 Analysis of the Integrated Care model

4.1 Environment

4.1.1 Spain and Spanish Healthcare System

The Kingdom of Spain is a sovereign state in south-western Europe. It is bordered by France, Andorra and the Cantabrian Sea to the north, the Mediterranean Sea to the east, and to the south, Portugal to the west and the Atlantic Ocean to the south- and northwest. Spain has some territories outside its continental territories: Balearic Islands in the Mediterranean Sea, Canary Islands in the Atlantic Ocean and Ceuta and Melilla in the African shore of the Strait of Gibraltar.

Spain became a parliamentary monarchy in 1978. Under this regime, the king proposes the Prime Minister to the Lower House of Parliament for approval after every national election. Then the Prime Minister designates the Ministers for different affairs which form together the Government cabinet. Spain became a member of the European Union in 1986.

Spain is a decentralised country and comprises regions (named *Comunidades Autónomas*, Autonomous Communities – AC -) which have exclusive powers in fields such as finances, education and healthcare provision. The ACs are political-administrative entities, created with the objective of ensuring the autonomy of the different historical nationalities within Spain. According to data from the Spanish National Institute of Statistics, in July 2014 Spain had a population of 46.464.053 inhabitants[1]. Spanish population has decreased significantly since the beginning of the economic crisis in 2008, especially in the case of foreign nationals who do not find the same job opportunities.

Life expectancy in Spain is one of the highest in the Europe, especially in the case of female population. According to the WHO's World Health Statistics 2014[2], in 2012 female life expectancy in Spain was 85.1, the 2nd highest in the world, behind Japan. Besides, according to data from the Spanish National Institute of Statistics, by the end of 2011 up to 17.3% of the overall population was over 65 years old. Finally, and according to data from the World Bank[3], the birth rate in Spain in 2012 was of 10 new-borns for each 1,000 inhabitants, one of the lowest in the world. Hence, the population in Spain, following the trend of most developed countries, is rapidly growing older: it is estimated that by 2050 the population over 65 will account for 36.5% of the population.

The Spanish healthcare system is a National Health System that provides Spanish citizens with universal coverage, as defined in the Spanish Constitution of 1978. The Spanish National Healthcare System (SNS) was established following

[1] http://www.ine.es/en/inebaseDYN/cp30321/cp_inicio_en.html (in Spanish)

[2] http://www.who.int/mediacentre/news/releases/2014/world-health-statistics-2014/en/

[3] http://data.worldbank.org/indicator/SP.DYN.CBRT.IN

the Beveridge model: the Government acts as the main responsible for providing citizens with healthcare and the system is funded with assets from the General State Budget and supported by taxes. Healthcare provision is free of charge at the point of delivery, with the exception of some pharmaceuticals prescribed for citizens younger than 65, who are charged with 40% co-payment with some exceptions (unemployment, poverty, disability).

The National Ministry of Health, Social Services and Equality[4]) is the Government body responsible for the planning and execution of the national health policy and for ensuring right of citizens for health services. Therefore, the MSSSI is responsible for the regulation on pharmaceuticals or the definition of the minimum basket of healthcare services that should be provided by the Regional Health Systems. Nevertheless, management of healthcare provision has been delegated to the regional governments that operate service independently since 2002. Each of the 19 regions in Spain have complete jurisdiction over the healthcare delivery and organisation.

The organisation of the regional healthcare systems in each region comprises a Regional Health Ministry (*Consejería de Sanidad, CS*) meanwhile healthcare provision is guaranteed by the regional health service. CSs are responsible for the territorial organisation of health services and the customized definition of health policies (within the framework provided by MSSSI) (García-Armesto, Abadía-Taira, Durán, Hernández-Quevedo, & Bernal-Delgado, 2010). Figure 9 shows an overview of the structure of the Spanish National Health System:

[4] https://www.msssi.gob.es/estadEstudios/estadisticas/sisInfSanSNS/pdf/egspGastoReal.pdf

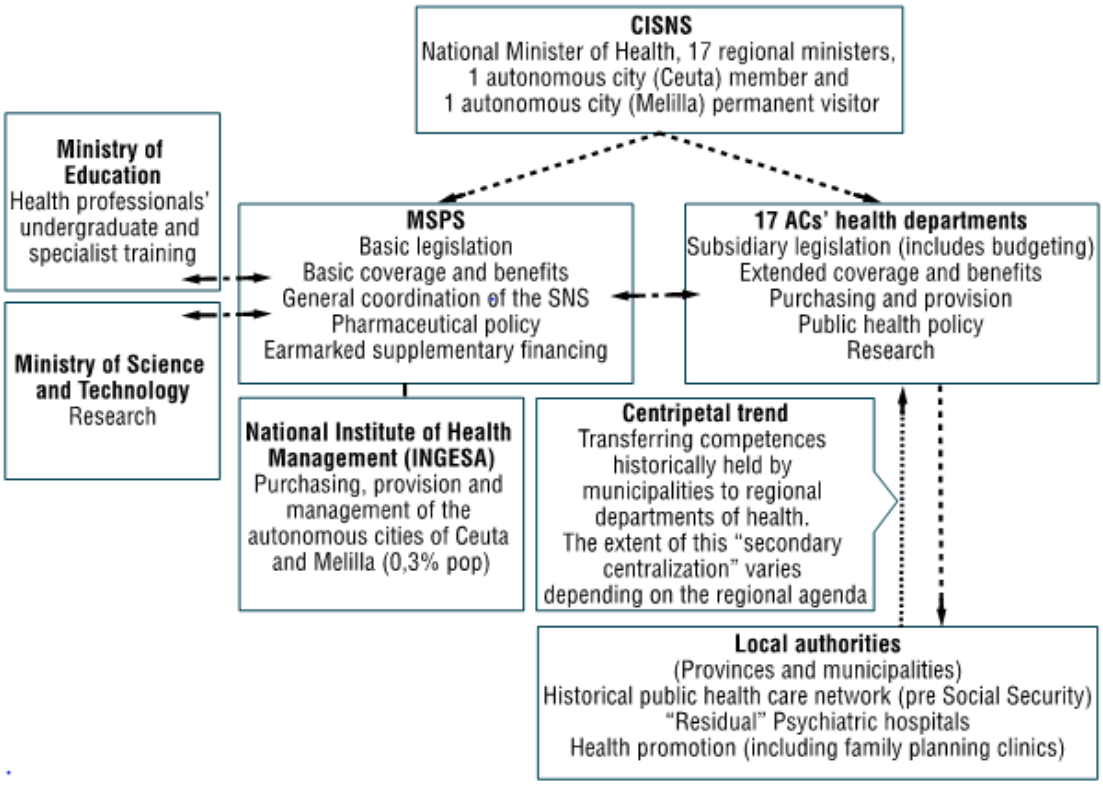


Figure 9: Spanish National Health System characterisation (García-Armesto, 2010)

Spain has been hit dramatically by the global economic crisis. With a current unemployment rate of around 24% of the labour force, Spain's GDP has dropped by approximately 6% from 2008 to 2015. This has provoked an unbalance in Spanish Social Security System which delivers unemployment and retirement pensions and funds Spanish Healthcare System. In order to respond this environment, the Spanish government has carried out public expenditure contention policies. Thus global health expenditure in Spain has dropped by approximately 4%, from €66,857,466 in 2008 to €64,150,289 in 2012. From 2007 to 2011, the average annual growth rate of the total healthcare expenditure was 2.5% (3.0% in public expenditure and 1.4% in private expenditure) Cuts in healthcare funding were especially dramatic in 2012, when the budget of the Ministry of Health, Social Services and Equality was reduced by 5.7%. In July 2012, pharmaceutical co-payment was introduced: medication for treating minor conditions was excluded from the free healthcare service provision, while co-payments depending on revenues were established for medicines for more serious or chronic conditions. Moreover, irregular immigrants and Spanish long-term unemployed citizens over 26[5] without were excluded from healthcare system shows the evolution of the health expenditure in Spain from 2007 to 2012, including long-term care.[6]

[5] http://www.seg-social.es/Internet_1/Normativa/169476

[6] https://www.msssi.gob.es/estadEstudios/estadisticas/sisInfSanSNS/pdf/egspGastoReal.pdf

€ Millions	2007	2008	2009	2010	2011	2012
Public Health Expenditure	64.232	70.848	75.355	75.007	72.510	68.607
Private Health Expenditure	25.169	26.244	25.120	25.875	26.312	27.064
Total Expenditure	89.401	97.092	100.475	100.882	98.823	95.670

Table 5 Health Expenditure in Spain from 2007-2012

Health expenditure in Spain reached 9.4% of GDP ($US 2998 per capita) in 2011, slightly above the OECD average (9.3%). As expected in a Beveridge model, public funds supported most of the budget, amounting 73% of the total budget. (OECD Health Statistics, 2014) These public resources are collected mainly by taxation (94.07% of total), while payroll and employers' contributions to the work injuries and professional diseases mutuality schemes amount to 2.53% of public assets; the mutual funds catering for civil servants deal with the remaining 3.4%.

The Spanish National Government provides AC with general resources[7] according to their population, area and their particular conditions (e.g. insularity). ACs have the freedom to allocate funds among their Ministries which brings out heterogeneity in health expenditure per capita and access to different baskets of service. Each AC can give more or less importance and support to healthcare issues. For instance, in 2009 the public health service of Extremadura (one of the poorest and least developed AC) spent €1,560.82 per capita, while the one form La Rioja (much wealthier) spent €1,094.98. (García-Armesto, 2010)

Private Voluntary Insurance (PVI) plans play a minor role in Spain, and are mostly as a complement to public services. Users of private plans look for specific specialties such as Dental Surgery or to avoid waiting lists (5.9 % of total healthcare expenditure). Citizens can freely contract health care services from private health insurers (e.g. Sanitas, Adeslas, AXA, etc.) and get service from private health providers (e.g. Quirón, Ruber, etc.) or independent specialists.

[7] Basque Country and Navarra have special conditions due to historical issues. They self-finance and support their own regional services (health, regional police bodies, etc). Contrarily, they must reimburse an annual invoice for the services provided by the Central Government (National police, Justice, etc).

Moreover, some of those health insurers own and manage their own hospitals and clinics so they work both as health providers and payers. 13% of the total population in Spain is covered by private health plans (García-Armesto, 2010).

In recent years Spanish health-policy makers have shifted the model for healthcare system engineering. They are wagering for a mixed healthcare system model combining public funds and private operation. Some services such as hospital management, imaging diagnostic tests or surgery have been outsourced to avoid waiting lists in public facilities and to promote better control over the available resources and efficiency. However, skepticism among the public has raised due to some corruption scandals on the allocation of contracts. This scenario has led policy makers to reflect about the whole healthcare model.

The Spanish legislation establishes a set of criteria for classifying hospitals and medical centres depending on the specialties and services offered. The Order 146/1985, updated in May 23, 2014, provides the following definitions of healthcare settings for the provision of in-patient care:

- Level 1 Hospital: Acute General Hospital comprising the adequate units and service in order to provide citizens with healthcare at a district level. It might comprise higher-level services and be complemented with services in the same scope provided by other centres.

  In order to be qualified as a Level 1 Hospital, a hospital has to provide the following services: General Medicine, General Surgery, Traumatology, Gynaecologic Obstetrics and Paediatrics. Optional services include an outpatient Nephrology Unit with consultations and dialysis and specialities such as Ophthalmology, Otorhinolaryngology, Urology, Cardiology and Psychiatry.

- Level 2 Hospital: Acute General Hospital comprising the units and services required to provide citizens with top-level healthcare at a Health Area level. Level 2 hospitals may include regional-level services and be complemented with other highly specialised services located in other centres.

  Level 2 Hospitals provide acute patients with care in the following specialties: Internal Medicine, General Surgery, Traumatology, Gynaecology, Paediatrics, Nephrology, Psychiatry, Ophthalmology, ORL, Urology, Cardiology and Dermatology. Optional services, depending on planning criteria, include specialities such as Paediatric Surgery, Cardiovascular Surgery, Neurosurgery, Thoracic Surgery, Plastic Surgery and Maxillofacial Surgery.

- Level 3 Hospital: Level 3 hospitals are subject to similar conditions to those applying to level 2 hospitals, with some slight differences. For instance, one physician from each clinical and diagnostic service has to be available within a timeframe of 20 minutes, and other professionals have to be on standby. Besides, designated spaces for a Resuscitation Room, a Radiology room and one Surgery Room should be available.

- Medical-Surgical Clinic: Acute care hospital with units for treating citizens under medical or surgical processes. Optionally, they can offer obstetrical care or specialised medical or surgical care. Specialties can include Oncology, Obstetrics, Traumatology, Cardiology, Psychiatry, Nephrology, Paediatrics or Infectious Diseases.

- Minimum Care Hospitals for medium and long stays: hospitals that provide care for patients who need to be hospitalised for more than 30 days in 50% of cases. They usually provide care for pathologies for which no high-cost equipment is required.

It is worth noticing that general hospitals in Spain are not required to have a Geriatrics Service in order to be considered as Level 1 or 2 hospitals. This gives an idea of the general perception of Spanish medical community on Geriatrics, that is not considered a core and relevant field in medical activity but a palliative discipline

4.1.2 Comunidad de Madrid and SERMAS

Comunidad de Madrid is a region in the centre of Spain. It is the third most populous (6,495,551 inhabitants) and the most densely populated (809.11 inhabitants/km2) region in Spain. Almost, half of its inhabitants live in the largest city, Madrid (3,165,235 inhabitants, Padrón Municipal de Habitantes, 2011). Móstoles, Fuenlabrada or Alcorcón are also important population nuclei which merge into the Madrid Metropolitan Area, the largest economic focus in Spain. The Region of Madrid has the second largest GDP per capita in Spain (€31,600), slightly below the Basque Country (€32,200) and remarkably above the Spanish average (€23,000) (Eurostat, 2011). Although Madrid is a wealthy and developed region, public expenditure in health is low (4.1% of GDP) when compared to other Spanish AC (5.8% of total GDP on average) (García-Armesto, 2010).

The Consejería de Sanidad de la Comunidad de Madrid (Ministry of Health of the Region of Madrid) is the regional body responsible for the healthcare services in the Madrid Autonomous Community. Nevertheless, its function is mainly organisational and financial and Healthcare services are delegated to the Servicio Madrileño de Salud (SERMAS, Health Service of the Region of Madrid). The SERMAS is led by the Regional Vice-Ministry of Health. It was created in 2001, along with the Health Institute of Madrid, as a consequence of the devolution of health competences from the National state to the different regions in Spain. Later, in 2005, the Health Service of Madrid was integrated with the Health Institute of Madrid. Its name changed to SERMAS and it was established to avoid duplication and foster rationalisation, efficacy, simplification and efficiency in healthcare provision.

Order 23/2008 established the organisational structure of the SERMAS which comprises a set of General Directorates, including for Primary Care, the General Directorate of Hospitals, the General Directorate of Patient Service, the General Directorate of Economic Management and Procurement of Healthcare and Pharmaceutical Products, the General Directorate of Human Resources, the General Directorate of Health Information Systems and the General Directorate of Management and Control of the Healthcare Centres Under Indirect Management. In 2014, Order 23/2014 changed the organisational structure of the SERMAS to improve its efficiency. The General Directorate of Hospitals was renamed to

General Directorate of Specialised Care, and the General Directorate of Management and Control of the Healthcare Centres under Indirect Management was discontinued, and its competences transferred to the General Directorate of Specialised Care and the General Directorate of Economic Management and Procurement of Healthcare and Pharmaceutical Products.

Moreover, Law 6/2009 re-organised the overall territory of the Region of Madrid, merging the 11 Healthcare Areas in the Region into a Single Healthcare Area. One of the main objectives of the integration of all health areas into a single health area was to ensure the free choice of physician within the whole region, one of the main initiatives promoted by regional governments. Order 52/2010 defined the basic structures of the Single Healthcare Area including the Basic Healthcare Area, which is the territorial framework where health centres carry out their activities.

4.1.3 Getafe and the University Hospital of Getafe

Getafe is a medium-sized residential town in the southern Madrid's metropolitan area. It grew as one of the main nodes in the road Madrid-Toledo and is well-known for the Getafe Air Force Base and its football team. Besides, Getafe is home of one of the five public Universities in the Region of Madrid: Universidad Carlos III de Madrid. Getafe developed remarkably in the 50s, 60s and 70s due to the industrialization of the area and the establishment of many international companies such as Ericsson, Siemens, John Deere, etc. This settlement fostered the immigration of young workforce looking for a job from other regions in Spain like Andalusia, Extremadura and Castile-La Mancha. Since 1950 the population has grown over tenfold from 12,254 in 1950 to 170,115 in 20118. This demographic pressure demanded the construction of a reference hospital as the access to specialized medical services was constrained by the distance to General Hospitals in Madrid.

The HUG started its operations in 1991, providing service to over 200,000 inhabitants and covering 13 municipalities including urban centres like Getafe (over 170,000 inhabitants) and Pinto (over 47,000 inhabitants in 2014). Most of these citizens use the public health service, especially older patients. Although regional legislation provides patients with the possibility to choose the hospital where they want to be attended, the University Hospital of Getafe attends more than 90% of the patients in its coverage area. Besides, due to the high price of building land in the city of Madrid, during the 1990s and 2000s several nursing homes were built in the outskirts of the city, in places like Getafe. This means that many users from the centre of Madrid, who were attended in hospitals in the centre, were institutionalised in nursing homes in Getafe, which increased the elderly population in the scope of the HUG.

Within the SERMAS network, HUG is a Level 2 hospital with a staff of around 2,300 people and it offers up to 39 specialties, including key specialties such as General Surgery, Cardiology, Paediatrics, Genetics or an Intensive Care Unit (ICU). Despite its youth, the HUG is recognised as a reference hospital in specialties such as the Burn Unit, the Transplants Unit or the Tissue Bank. It is remarkable that only 6 out of 37 hospitals in the Region of Madrid count on a

[8] (Instituto Nacional de Estadística (INE),2011)

Geriatrics Service: the Ramón y Cajal Hospital, the Gregorio Marañón Hospital, the San Carlos Clinical Hospital of Madrid, the Red Cross Hospital, the La Paz Hospital and the University Hospital of Getafe. Newly created hospitals have geriatricians among their staff, but do not have a proper Geriatrics Service. Among the 6 Hospitals that have a Geriatrics Service, only 3 of them offer outpatient services. Finally, as a University Hospital, the HUG also has a teaching facility, and is accredited to teach the Degree of Medicine in collaboration with the Universidad Europea de Madrid.

4.1.4 Geriatrics Service at Hospital de Getafe and Integrated Care Program

Amongst all the services provided, the HUG has a Geriatrics Service that attends more than 5,000 older patients every year. Its staff comprises 10 physicians, 15 residents, 1 occupational therapist, nurses for the hospitalisation area, day hospital and consultation and administrative staff. The 10 geriatricians are divided into different units as follows: (1) the Community Care Unit has 2 professionals; (2) the Outpatient Office and Day Hospital, 1 professional; (3) the Falls and Fractures Unit, 1 professional; (4) the Acute Care Unit, 4 professionals, (5) the Liaison Team, 1 professional and, finally, (6) a Head of the Geriatrics Service. Support staffs include 1 secretary, 1 assistant nurse and 2 dedicated nurses (1 in the Acute Care Unit and 1 in the Geriatrics Service), 1 occupational therapist and 1 social worker, shared with other services in the Hospital.

Besides the regular service at hospital facilities, for the last 20 years the Geriatrics Service of HUG has worked to reach the highest quality standards and to promote the efficiency of resources. They aim to shift the perception of other healthcare professionals that consider Geriatrics a palliative branch, unable to reverse the condition of elderly patients. Thanks to those efforts, the Geriatrics Service at HUG has been selected as a Reference Site within the European Innovation Partnership on Active and Healthy Ageing, where it has been awarded 3 stars (highest qualification).

4.2 Culture at the Geriatrics Service

In the following paragraphs I describe the organisational structure of the Geriatrics Service that has enabled the implementation of the **integrated care program.** This approach aims to provide the most appropriate continuous, progressive and coordinated care to patients at risk of functional decline, institutionalisation, and hospitalisation. Care services for chronic patients are extended to every setting where they live, including home and nursing homes, to guarantee the comprehensive and seamless delivery of care. This outreaching extension of healthcare delivery enhances the accessibility of complex patients to care services and enables the seamless assessment of users and the safest, fastest and most personalized refinement of Disease Management Processes (DMP). '**Care continuum'** has been established in the Geriatrics Service as the most appropriate to meet the changing needs of elderly patients.

Besides continuity and consistency in the delivery, the rearrangement of services also promotes the efficient use of resources and facilities. The intervention of healthcare professionals at earlier stages of ageing or disease processes either in the community or at Primary Care setting reduces the use of costly in-patient acute care services (one bed at the

acute care costs €311/night). Besides, the Geriatrics Service has modified the criteria for the admission in the inpatient care settings. They carried out a 15 month study during 2006 and 2007 to inquire the appropriateness of the revaluation of patients derived from the Emergency Room by a Geriatrician. Under the new criteria 62.3% of patients who were initially admitted by the Emergency Room physician were discharged after the revaluation. They computed as inappropriate admission and were referred to other ambulatory facilities or to the community, where patient's assessment and intervention may be easier, more accessible, more appropriate and cheaper. Thanks to the reallocation of the patients the Geriatrics Service saved approximately €619,512 in the 15 month period without any reported negative consequences on patients (Bouzón, 2010). Contrarily, the integrated care program has impacted positively the general health status of the elderly population under it. Thus, the average length of stay in their Acute Care Unit It is 2 days shorter (6.8 vs 9.1) than in other departments at the hospital which attend patients with a similar case-mix, but apply traditional care models. In this sense the reduction has brought savings of around €1,000/patient. Taking into account that the Acute Care Unit attended 1,706 patients in 2014, the total thrift due to the new strategy rises to around €1,7M in the last year (Internal data from the hospital, December 2014).

Furthermore, the head of the Geriatrics Service is aware of the potential application of technology in integrated care approaches. By the collaboration with the HUG Biomedical Research Foundation, the Geriatrics Service participates in ICT-based European projects, providing a critical mass of patients for the intervention in real clinical environment and observation. In addition, they have conducted some trails to inquire the impact of technologically supported models in clinical pathways, disease management and patient's status. For instance they carried out a two year randomized, non-blinded study aiming to investigate the clinical benefits and feasibility of integrating an ICT-based tele-monitoring system to remotely assess patients suffering from Heart Failure. Patients were provided with a smartphone with a dedicated application and a set of measuring devices, such as a blood pressure cuff and a weight scale, and were requested to regularly report their measurements and other information such as their functional status or symptoms. A total of 90 patients participated in the study, 72.2% were women and the median age was 86. In total, 50 patients were included in the intervention group, and 40 in the control group. The intervention group had a better clinical outcome than the control group. Clinical outcome was defined as a composite indicator composed of the number of visits to the Emergency Room (ER) and the number of readmissions. Moreover, in the intervention group, 80% of readmissions were shorter than or equal to 7 days long, while in the control group the length of stays reached 13 days. Apart, in the intervention group the gait speed variability and oxygen saturation were statistically significant as clinical markers, while other variables such as blood pressure or weight were not meaningful. Finally, the reduction of length amounted for an estimated cost saving of approximately €1,750 per patient and the study demonstrated the feasibility and effectiveness of using tele-monitoring systems to remotely follow-up older patients with chronic conditions. The results of the trial will be published in 2015.

Apart, the Service is in direct contact with new clinical research findings. They transfer newest care approaches to the regular clinical practice and the model is continuously refined and adapted to those outcomes. For instance, following the last discoveries in healthy ageing and chronic disease management the Geriatrics Service has moved the focus from the

traditional comorbidity-based evaluation of patients towards a functionality-based approach, as it may provide physicians with more reliable and complete information of patients' disease conditions status and degree of disability. The Geriatrics Service follows a dedicated protocol for the assessment of the elderly: the Comprehensive Geriatrics Assessment (Valoración Geriátrica Integral-VGI). It is a multidimensional assessing tool that targets a set of factors and it provides geriatricians with a quantitative and qualitative measure of the medical, psychological and functional capabilities of diseased patients (Rubenstein, 1990), (Wieland, 2002).

Type of evaluation	Component	Description
Clinical Evaluation	**Self-perception on the disease**	Perception of patients on their age-related conditions and disease as reversible process
	Disease Processes	Changes in the frequency, nature and presence of disease and comorbidity. Information from Diagnostic tests.
	Diagnose-Therapeutic decisions	Assessment of the impact of continuous treatment refinement and disease management processes on patient clinical status
Functional Evaluation	**Physical**	Assessment of the physical status of the patient: performance, gait pattern, gait speed, grip strength, etc.
	Cognitive	Evaluation of the l mental abilities and processes related to knowledge: attention, memory and working memory, judgment and evaluation, reasoning and "computation", problem solving and decision making, comprehension and production of language, etc.
	Affective	Evaluation of the emotional abilities of patients.
	Social	Evaluation of patient's socioeconomic environment. Support from relatives, friends or informal caregivers. Evaluation of social abilities

Sensory	Evaluation of visual, auditory and proprioceptive (vestibular and motor) capacities.

Table 6 Components of Comprehensive Geriatric Evaluation (Rodríguez Mañas, 2001)

The comprehensive functional evaluation of the elderly seeks the definition of **frailty**. It is defined as a measure of the vulnerability of patients to poor resolution of homeostasis after a stressor event, which increases the risk of adverse outcomes, including falls, delirium and disability. These stressors (e.g. new drug, minor infection minor surgery) would not imply further complications events in robust patients. However they may lead to the remarkable worsening in the case of frail patients and finally to adverse and irreversible events such as falls, incident disability, hospitalization, and mortality (Clegg, 2013), (Xue, 2011). The processes involved in ageing are complex and have not been understood yet. Both genetics and environmental factors lead to cumulative molecular and cellular damage and the loss of physiological reserve. Finally, this processes produce impaired organ functioning and disease. If evaluation of the elderly patients was established based on co-morbidity, the intervention of healthcare professionals may be late and the consequences of ageing on patients may be already irreversible or disabling. As a result patients and the healthcare organisation would be aggrieved, both in health and economic terms.

Recently, geriatricians have sought a formal classification for frail patients or at risk for frailty. They have put the focus on their disability status, functional performance or a combination of either with comorbidity, neurosensory problems, or adverse geriatric outcomes (Winograd, 1991), (Strawbridge, 1998). Some of these studies have related those factors with increasing length of hospital stay, nursing home utilization and mortality (Winograd, 1991).

After in-depth discussion, experts in Geriatrics have agreed Linda Fried/John Hopkins Frailty Criteria as the better tool to range frail elderly patients. They emerged in a study which included clinical, emotional, functional (ADLs and IADLs), physical assessment of elderly patients in the USA. These markers merge age-associated declines in lean body mass, strength, endurance, balance, walking performance, and low activity. It has been proven that they are not significant independently but multiple components must be present clinically to constitute frailty. They have been adopted prevalently thanks to the simplicity of the required trials that basically involve a dynamometer, a scale and a chronometer and may be carried out by nurses or nurse assistants. Moreover these factors are reliable markers for the prediction of incident falls, worsening mobility or ADL function, incident hospitalisation, and death. According to Linda Fried/ John Hopkins Frailty scale patients are considered to be **frail** if they present three of the five Linda Fried/John Hopkins frailty criteria, while those that present one or two are **pre-frail** and those with no characteristics are diagnosed as **robust. These criteria are shrinking; weakness; poor endurance and energy; slowness; and low physical activity level.** (Fried, 2001)

Criteria	Description
Shrinking	Unintentional weight loss of 10 pounds in prior year or, at follow-up, of 5% of body weight in prior year (by direct measurement of weight).
Weakness	Grip strength in the lowest 20% at baseline, adjusted for gender and body mass index.
Poor endurance and energy	Indicated by self-report of exhaustion. Self-reported exhaustion, identified by two questions from the CES–D scale (36), is associated with stage of exercise reached in graded exercise testing, as an indicator of O2 max, and is predictive of cardiovascular disease.
Slowness	The slowest 20% of the population was defined at baseline, based on time to walk 15 feet, adjusting for gender and standing height.
Low physical activity level	A weighted score of kilocalories expended per week was calculated at baseline based on each participant's report. The lowest quintile of physical activity was identified for each gender

Table 7 Linda Fried/ John Hopkins Frailty criteria (Fried, 2001)

The comprehensive evaluation of patients and the early monitoring and control over frailty are key concepts for the integrated care program. The articulation of the Geriatrics Service follows these trends. Besides the expansion of service to reach care continuum, the concept of frailty and the functional assessment of patients provides better understanding and reliable information on ageing processes and patients conditions. Thus, the Geriatrics Service can devise personalized preventive plans to promote patient's health and the efficient and wise allocation of resources.

4.3 Integrated care program structure and implementation

The **integrated care program in the HUG** harvests the culture in the Geriatrics Service that promotes the best healthcare provision and the efficient use of resources and settings. It has been designed mainly on two strategies: (1) transition of discharge plans from in-patient settings to the community and (2) prevention of falls. Both of them promote the rational use and allocation of resources and the provision of the best services to the elderly. These two strategies reflect the innovative spirit of the Service into real implementation in healthcare. They boost integration beyond the regular services delivered by Geriatrics services at other hospitals. Although the program is included in the free basket of

services, the specialists from the Geriatrics Service work as gatekeepers: they decide whether the patient is appropriate for the plans or not.

4.3.1 Domiciliary assessment of elderly patients: Community Care Unit

Amongst the different units that merge in the Geriatrics Service, the **Community Care Unit** (hereafter CCU) arises as the core element for the continuum of care. This dedicated service aims to smooth the discharge process from the Acute Care Unit either to the community or to other units at the Hospital, by enhancing information availability and coordination of all care agents involved. Moreover, it serves patients who are in the community, but are in risk of hospitalisation due to their unstable conditions. The CCU enables vertical integration (it implies the combination of different organisations/units at different levels) of the Geriatrics Service with Primary Care, nursing home agents and with informal caregivers at the community by different means:

- First, they hold multidisciplinary meetings with doctors from the Acute Care Unit, from other levels of care in the Geriatrics Service and the hospital's social worker. In those meetings they devise customized discharge plans for each patient, depending on the functional capabilities and socioeconomic status (i.e. family structure, caregivers, etc.) of patients. Other organisational issues are also considered, such as bed availability and professionals in the care network. The plans include the most appropriate place for referral and the assessment and interventions that should be carried out. Once patients are discharged, the CCU geriatricians communicate the plan in place to either Primary Care general practitioners (who are case managers in the community) or physicians in other Hospital Services (when they are referred to other inpatient setting). This communication is elapsed till the end of the process, and CCU geriatricians keep the track of discharge, supporting primary carers and colleagues in other Services and refining the initial plan until patients' status is stabilized.

- Besides, the CCU geriatricians perform ambulatory assessment of patients in the community on a regular basis. They carry a '*medical toolkit*' comprising a laptop, a small printer and a 3G USB drive, so they can remotely connect to the hospital's Virtual Private Network, and some measuring devices, such as a blood pressure cuff or an oxygen saturation meter. The geriatricians can access patient's medical record from the hospital's Health Information System at the beginning of the visit, and can later upload the information gathered during the visit (measurements, questionnaires, etc.). Moreover, professionals in primary care can also access this information.

  The employment of technology in the model (use of a laptop, a small printer and a secure connection to the hospital) has promoted integration in terms of information sharing. Before the use of the toolkit, physicians who performed the home visits had to ask for the patient's record 24 – 72 hours in advance. Moreover, they had to carry physical copies of the patient's record to the patient's home or nursing home. During the visit, physicians used to fill two copies of a visit report, one for the patient and one for the Geriatrics Service. In case the patient wanted to share information about the visit with a health professional in primary or secondary care, they had to

take the physical copy of the report with them. Nowadays, the medical toolkit allows travelling physicians to connect to the hospital's intranet and to view, edit and create patient records. Therefore, all data gathered during the visit can be uploaded on site to the hospital's intranet and are available to other services in the hospital. Moreover, approximately 3 years ago the hospital's IT Department provided primary care with access to the hospital's intranet. Nevertheless, no integration has been carried out with the information systems of other stakeholders, such as nursing homes. Nursing homes have their own proprietary information systems where they store data about their clients. These information systems are not connected at all with the hospital's Information System, hence preventing full integration of care.

- If no adverse conditions arise, the discharge plan is completed with a final assessment by the CCU. They provide patients with a discharge report, in which every concern or special needs of the patient are specified. The recipients are Primary Care GPs who keep the track in the community.

As a result, general practitioners can get a more complete overview of the health status of the patient right after the visit. The activity of the CCU has enabled the modification of discharge criteria in the Acute Care Unit and a reduction in average length of hospitalisation. Moreover, the seamless integration of all stakeholders in the process enhances the continuity in the assessment of patients thus preventing the occurrence of sudden adverse events and rehospitalisation.

There are four entry points for patients in the CCU:

- Nursing homes can send lists of patients who are candidates to join the programme.
- On request from the GP who is the final disease manager in the Spanish healthcare system.
- Discharge from Emergency Room or other service in the Hospital. The patients discharged from the ER who are not hospitalised but are considered unstable are also referred to the Integrated Care Program offered by the Geriatrics Service.

4.3.2 Preventive therapy for frail and unstable patients: Day Hospital and Falls Clinic

The **Falls Clinic** at HUG was established in 2009 to both treat those patients who are recurrent fallers or those who are in risk of falling. Apart from the direct consequences a fall may have in any patient (mayor and minor fractures, traumatic brain injuries …) falls may become severer events in the case of elderly patients. The approach aims to assess the risk of falls and fractures in all subjects at risk, intervene whenever needed and follow-up patients in rehabilitation. This unit has established a research environment that allows the development and validation of assessment tools and intervention models. According to the data provided by the HUG, this unit serves a total 620 patients/year.

The Falls Clinic targets the recovery time in the older, and the associated functional decline, which may lead to irreversible processes. Although most falls do not end in death, prolonged immobility produces joint contractures, pressure sores, urinary tract infections, muscle atrophy, psychological depression and among others. As a result, falls are a common reason for institutionalization. Approximately 25% of hospital admissions of the aged are directly attributable to falling, and 47% of patients admitted to the hospital for falls become long-term-care stay patients. Besides, fall-related mortality increases with advanced age and more than doubles with each decade of life. For instance, 40% of elderly patients who break their hip die within 6 months of the injury. Apart, falls with no clinical consequences may finally trigger self-imposed immobility that arises from the fear to re-fall. This scenario enhances functional decline, and make patients even more prone to a re-fall (Tideiksaar, 1988).

Falls are sudden events and difficult to predict due to the multiple variables and physiological conditions that may be relevant. Although the etiology of recurrent falls has not been fully understood, researchers have pointed both ``normal´´ ageing physiological changes and extrinsic environmental factors as determinant drivers for falls. The Geriatrics Service performs the multidimensional assessment of patients who are fallers or potential fallers aiming to develop preventive plans. The professionals in the Falls Unit have targeted specially three systems (visual, vestibular and proprioceptive) that are significant for the control of the body and the prevention of falls. The evaluation of patients in this sense is carried out merging the information from regular clinical practice, composite trials like posturography, gait patterning and physical performance timing; and data from methods like dual-energy x-ray absorptiometry or bioelectrical impedance analysis that help determine body composition. Besides, the socioeconomic environment of patients, the effect of the intake of multiple drugs. Finally some Geriatrics scales are employed to screen cognitive impairment (Mini-mental, Folstein, 1975), self-maintaining and basic activities of daily living (Barthel index, Mahoney, 1965) instrumental activities of daily living (Lawton & Brody scale, Lawton, 1969), depression (Geriatric Depressions Scale, Yesavage, 1983), which are also good predictors of fall risk.

There are two inclusion criteria in the Falls Unit, which makes patients eligible:

- Repetitive falls (two or more falls the last year)
- Falls with clinical consequences or that required medical intervention.

Another important element in the Integrated Care Program is the **Day Hospital,** where older patients with different pathologies and degrees of disability undergo rehabilitation programs in order to enhance their independence and quality of life. The occupational therapist in the Day Hospital designs programs that target functional recovery of the elderly and promotes the fastest reintegration in their normal life. Moreover she educates patients on good practices in their daily life and teaches them how to react when they suffer an adverse event such as a fall or orientation loss. Finally the training stage in the Day Hospital also has a positive impact in the psychological state of the patients. In the Day Hospital they

meet other patients with similar characteristics, which creates empathy between them. This encourages them to comply with the established program and align their efforts with the initiative.

Patient groups at the Day Hospital include patients with mild cognitive impairment, functional impairment (falls, fractures) or neurological injuries. They are referred to the service from different Units in the Hospital (Traumatology, Neurology, Otoneurology, Geriatrics, Orthogeriatrics, Geriatrics Acute Care Unit, etc.) through Peticion de Interconsulta (Consultation Request-PIC), that allow communication among physicians from different units who treat the same patient. Nevertheless, the final decision lies on specialists in the Geriatrics Unit, who perform the gatekeeping function.

The Falls Clinic and the Day Hospital are an example of the horizontal integration between two units at the same level which cooperate for the same goal. The occupational therapist produces feedback for the physician in charge of the Falls Clinic and they decide which interventions are more appropriate. The outcomes from this comprehensive analysis are employed to both educate patients and devise preventive plans, which are continuously remodelled and refined according to the evolution of patients.

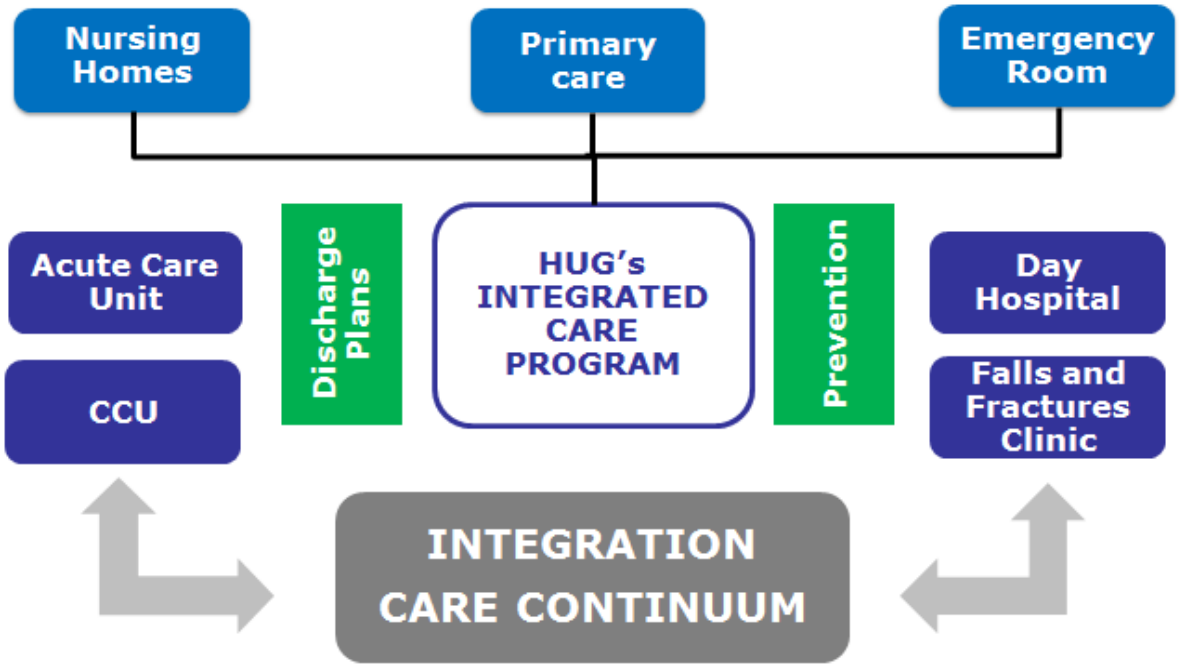


Figure 10 Operational chart of the Integrated Care Program

Despite the willingness of all professionals in the Geriatrics Service to enable the change and promote the integrate care model, and the promising outcomes of the pilots and trials carried out, the integrated care program has faced several barriers during its implementation. Moreover, the transference to other similar hospital centers or the scaling up as a general approach in the delivery of healthcare to the elderly are hindered by factors that will be outlined below.

4.3.3 Analysis of the integrated care program

The **reorganisation of services** at the Geriatrics Service has been successful. The Community Care Unit and the Day Hospital have enabled the transition from the hospital environment to the community smoothly, enhancing the access to medical assessment and ensuring the continuum of care, promoting a **patient-centred** approach.

4.3.3.1 Policy environment and governance

Moreover the Geriatrics Service achieved these results without the need for expensive equipment nor complicated procedures, but just allocating funds and efforts in a more rational manner. The integrated care program has been implemented replicating the structure of the Red Cross Hospital in Madrid and tuning it to meet local conditions and models of care. Thus, similar initiatives might be launched locally at other hospitals similar to HUG, once main barriers and the processes to overcome them have been identifies. However, despite the positive impact of the model at local level, the **policy environment** and the absence of regulatory laws in Spain and in the Region of Madrid hinder the scalability of the idea and its expansion as a general approach in the whole Servicio Madrileño de Salud (SERMAS) or in the rest of healthcare systems in Spain.

As with any innovative approaches, the implementation of an initiative such as the continuous and coordinated care programme faced two main hurdles: the need for funding and the involvement of professionals. As to the first item, it can be difficult to secure funding in the case of public hospitals, which usually have a closed budget and find it difficult to reallocate funds for initiatives out of the current practice. As to the second item, usually each service in the hospital is bound to rigid practices, and generally professionals are reluctant to changes in the practice. Any innovative approaches needs to be integrated with the current practice; if not possible, a special effort has to be made to minimise disruption, and the benefits of the initiative should be clearly stated so as to gain the support of all involved stakeholders.

Indeed, in order to enable the provision of integrated care to patients in the area of Getafe, the Geriatrics Service of the HUG had to set up a coalition with different local stakeholders which comprises public health facilities (hospital-based and primary care), social care (both public and private), local authorities and representatives of older people. Moreover, in order to implement innovative initiatives aiming to improve the remote monitoring of patients at home - such as the HF Monitoring System tested in the pilot described previously -, the Geriatrics Service has established cooperation with different public and private stakeholders. For instance, the HUG is collaborating with Saludnova, an SME from the Basque Country in Spain and other stakeholders to implement an initiative to assess the effectiveness of the use of a Personal Health System (PHS) for the remote monitoring of frail patients with diabetes. On the same line, the Geriatrics Service has

recently promoted a study, in cooperation with other Hospitals with well-established Geriatric Services (two in the United Kingdom, two in Italy and two in Spain), to assess the effectiveness of implementing coordinated care programs. Furthermore, the application of the new comprehensive and extended care model implied the direct creation of new jobs. More specifically, 2 new geriatricians were enrolled in the Geriatrics Unit of HUG, and 1 Nurse, 2 Clinical Pharmacologist and 1 Occupational Therapist were also hired. Besides, in 2014 3 engineers joined the team at the Hospital and an eHealth Unit was created. There is no specific initiative from the SERMAS or the HUG leadership to support integrated care for elderly patients. Thus, the Geriatrics Service has launched the program of its manager's accord and on its own assets.

4.3.3.2 Funding and financing model

The Geriatric Service is running a new additional service using the same resources as before introducing this service. In response, service managers have sought for alternative support. Most of the equipment required in order to implement the home visits and the Day Hospital has been paid with **funds from regional, national and European projects.** For instance, the materials such as the Laboratory for Functional Assessment, the GAITrite system, the position meter or the two ultrasound machines were financed by the European Union. Besides, the pilot on remote monitoring for patients with Heart Failure was funded by the Health Research Fund (HRF) of the Carlos III Health Research Institute. The main objective of the Carlos III is to promote and support research initiatives in the health domain. The HRF tenders for research provide strategic support for the National Research Programme. Moreover, the Carlos III Health Research Institute is responsible for all activities in the Health Strategic Plan, which are part of the National Scientific, Technical and Innovative Research Plan 2013-2016.

Apart, the Sub-Division for Innovation of the Regional Health Ministry in the Region of Madrid runs a Public Procurement for Innovation Programme (PPIP) whose main objective is to foster technology transfer in different domains. The PPIP is a European Regional Development Fund (EDRF) that implements the National/Regional Research and Innovation Strategies for Smart Specialisation (RIS3 strategies). The National Ministry of Economy and Finance is responsible for distributing the funds between the different regional governments. Within the Region of Madrid, there are 3 main lines of innovation: Health, Education and Government. In the last years, the health sector has received most of the funds of the PPIP program. Hospital foundations, health institutes and universities have created an environment that promotes research and innovation; hence, the research production is significantly higher in health compared to other fields such as Education or Government. In total, 80% of the products funded by the PPIP belonged to the health domain. It is important to remark that the PPIP is oriented towards the development of products that are commercially viable and ready for integration into routine practice. The most relevant criteria for eligibility are feasibility and competitiveness. PPIP funds are subject to the Procurement Law, and hence have to be completed within a 1-year timeframe. Furthermore, proposals have to include SMEs, mainstream manufacturers and health institutions such as research foundations or hospitals. The business fabric benefits the most from PPIP funds, as they receive funding for developing their products. On the other

hand, health institutions can benefit from PPIP funds, especially for the transition of new initiatives from research stages to actual clinical practice and their integration into larger systems. For example, the Geriatrics Service is currently preparing together with the Regional Ministry of Economy a proposal to get PPIP financing. Moreover they will bid in another PPIP (along with hospitals in other ACs), promoted by the Spanish Health Ministry.

4.3.3.3 Reimbursement model

Furthermore, the Geriatrics Service is aware of the need of the integrated care program to produce economic benefits, besides the pursuit of additional resources. Despite initial investments, which help the purchase and validation of the required technology in trials, no public institution supports the final implementation in regular clinical practice. Moreover, depending funds from national and European projects imposes a management overhead and adds uncertainty, as it is not easy to get long-term funding from such projects. Thus, the new model aims not only to provide better care and improve patients' clinical conditions and disease management, but it also seeks to reduce costs and become self-supportive. The Geriatric Service works with limited resources and every new initiative must be beneficial for patients and professionals, and profitable. Cost reduction is mainly achieved by lowering the average length of stay in the Acute Care Unit and reducing rehospitalisation of unstable patients.

4.3.3.4 Professional engagement

Although the Geriatrics Service has faced major financial barriers, the integrated care has been successfully implemented thanks to **professional engagement**. Due to the lack of extra resources, professionals do not receive any dedicated incentive for participating in initiatives such as the continuous and coordinated care programme: all professionals have the same basic salary depending on their seniority. In addition they receive a supplementary productivity bonus. However, 75% of the productivity bonus is fixed so productivity does not impact so much on the salary level. They have adopted the new approach as commit with more efficient and coordinated care management. The absence of incentives may hinder the engagement of other doctors to join or replicate the CCU or the falls prevention clinic, and the scaling-up of the integrated care approach.

Professionals in the Geriatrics Service and Primary Care GPs must be aware of what integration is, its benefits and how to implement it. They are educated and empowered since the very first. During their medical residency, all General Practitioners have to complete a stay in the they Geriatrics Service, where they can learn about all programmes and procedures adopted by the service. Moreover, all geriatricians have to rotate through the Community Care Unit and the Day Hospital and participate in the home visits and training programs. Therefore, after they complete their training both geriatricians and general practitioners are totally aware of the continuous and coordinated care program. On the other hand, other professionals from other services, such as emergency room physicians, might not receive any training in geriatrics or get informed about the work carried out by the CCU. The lack of training in geriatrics can have some drawbacks, such as inappropriate referrals, non-referrals for patients who could benefit greatly from domiciliary care and

the final increase in hospitalisations. These may lead to overuse or underuse of available resources, facilities and workforce. Besides, there are no standardised criteria for referring a patient to the Geriatrics Service. Therefore, it is up to the GP to decide whether to launch a Consultation Request to the Geriatrics Service. The lack of guidelines in this area can be a problem as older patients are often referred to the geriatrician only once they are in bad shape and at risk of developing or having already developed age-related disabilities. At this point, the inclusion in a training program at the Day Hospital may be useless. As a result, patients who could have benefitted from the prevention of sudden events and could have regained functional capabilities may have lost their chance, as their situation is beyond recovery. This leads to an increase in the number of readmissions and functional decline of otherwise patients who could have recovered. An integrated Health Information System and the definition of new protocols may enhance the appropriateness and timing of referrals.

4.3.3.5 Computerisation

The incorporation of information technology to regular care delivery has been a key driver to facilitate the success of CCU. The use of Health Information Systems in routine practice has facilitated the work of the doctors who carry out the visits patients at their homes or nursing homes. Before computerisation, physicians had to ask for the patients' records 24 – 72 hours in before the appointment, and had to carry all paper documents with them. During the visit, the physician wrote two copies of the report of the visit, one for the patient and one for the hospital records. Therefore, in order to share the information about the visit with a professional in primary care or specialised care the patient had to carry a physical copy of the report when visiting the professional, or the professional had to ask for the patient's history before an appointment. In order to overcome this overload of work and documents, the Geriatrics Service contacted the IT Department of the hospital in order to take advantage of the available Health Information Systems, even from a remote location. The IT Department set up a secure connection to the hospital's virtual private network (VPN), therefore allowing physicians out of the hospital to access patient records and upload new information to the Hospital's Health Information System. After this, professionals from primary care or other services in the hospital could have access to the information gathered during the visit right after it had taken place. However, the intricate **organisational processes** within the hospital and in relation to the Regional authorities hinder the implementation of innovation approaches. As an example, despite the collaboration of the hospital's IT Department, it took almost a year to get the USB 3G Drive that allows physicians to connect to the hospital's virtual private network. This gives an idea of the bureaucratic hurdles the CCU had to overcome in order to implement their vision. Moreover, some of the managerial and clinical personnel in the hospital considered that primary care should be responsible for providing patients with remote care at their homes or nursing homes and did not ease the application of community-based care services.

4.3.3.6 Communication barriers

Another barrier for complete integration is the **lack of a communication channels between patients and the CCU** which hinders the continuum of care and the comprehensive approach. The secretary of the Geriatrics Service is the only

current point of contact for patients who can reach her by phone. Thus, users only have access to CCU support during working hours and professionals are not always available. Moreover, phone calls are informal and there are no protocols for communication or any record of the outcomes that enable later analysis and sharing of the information. Although the Geriatrics service deals with a complex group of patients who often are not able even to use the telephone, the establishment of communication means and communication standards might allow the CCU unit to prevent sudden worsening and consequent visits to ER, hospitalisation and further avoidable interventions in some cases. The presence of an informal caregiver would be crucial in this feed-backing activity, as they may be empowered to play an active role and participate in the assessment and identification of worsening.

Summarizing, the degree of integration achieved by the Geriatrics Service can be considered as medium. Communication pathways do not reach all stakeholders in an efficient way and the interoperability of health information systems is not present at all. For instance, the between the Geriatrics Service and the rest of services and stakeholders is informal and mainly based on personal knowledge rather than on a solid information infrastructure. Currently different hospital services can exchange information about patients using the hospital's Information System. All services can use a system called x-GPC (or *Gestor extensible de Peticiones Clínicas,* a system allowing to manage clinical requests) in order to file a consultation request (*Parte de Interconsulta*) which becomes available to professionals in other services. A consultation request refers to the communication between two health professionals, where a professional asks another professional about a specific pathology. The consultation request is a fundamental tool in ensuring the link between primary and secondary care. However, it implies the active intervention of the agents to share information, besides comprising various steps. I would be desirable to build up an information infrastructure that supported automatic uploading of data and the one step, barrier-free retrieval of information by authorised physicians. In this sense, the X-GPC is not usually used as a bidirectional communication channel between the Geriatrics Service and other hospital services and units to coordinate the continuous care of patients outside the hospital, as it **does not outperform informal communication**. Thus, around 90% of patients in the program are referred by the Geriatrics Service, while dozens of them from other Services may also benefit from the program.

Nonetheless, the HUG has already developed a proprietary medical information visualisation tool, called Clinical Documentation (CD). CD aggregates data from different Health Information Systems available in the hospital. These HIS include medical imaging in PACS format, lab imaging, bronchoscopy reports, endoscopy reports, lab tests etc. CD is an Intranet application that can only be accessed from a local VPN. Thus, nursing homes and other stakeholders are not allowed to access the information. Furthermore the set of data supported by **CD is not the most valuable** for the integrated care model.

HUG is working on implementing a new Health Information System, namely the "HP HCIS", an integrated Healthcare Information System developed by Hewlett Packard. HP-HCIS will be deployed in 2015 in 7 hospitals in the Madrid Region, while another 3 hospitals will integrate HP HCIS with the other Health Information Systems in their hospital. Moreover, the General Directorate of Health Information Systems of the Region in Madrid, which is responsible for the strategic

orientations of the Regional Health Ministry, is working on the implementation of a visualisation system named HORUS. HORUS aggregates data from different Health Information Systems: administrative data from the platform that manages all horizontal aspects of health information such as the unique identification of the patient or the administrative data of the patients (named CIBELES); primary care information, stored in the OMI-AP and AP-Madrid services; and secondary care information, including secondary care reports extracted from the HIS of the hospitals (SELENE, HP-HCIS, DC, etc.) that store clinical reports and patient cases, digitalised reports or digital imaging (PACS, RIS) amongst others. However, these systems **have not been implemented** on real clinical practice yet.

The lack of Integration with social services and nursing homes is also a barrier hindering fully integrated care. As stated earlier, nursing homes have their own databases where they store information about their patients, and these databases are totally independent from the databases in the hospital's Health Information System. Moreover, only professionals from the hospitals and professionals from primary care are provided with access to the data uploaded. Moreover, each nursing home or nursing home company can have their own proprietary database, and there is no obligation for these databases to comply with healthcare standards such as HL7 or CDA. Furthermore, there is some resistance from social services and nursing homes to fully integrate with the rest of healthcare agents. Their perception of the new model and commitment to it should be improved to ensure the highest degree of integration. Nevertheless, integration with social services is out of the remit of my Bachelor Thesis, as healthcare organisations are not responsible for the delivery of social services in Spain.

The lack of communication pathways and the inefficient HIS supporting them has hindered the proper functioning of the integrated care program, increasing the workload on professionals and constraining information availability, actions alignment, and thus continuum of care. I identified a set of problems that may overcome by the implementation of an improved health information system:

- When professionals need to harvest additional information on one patient from other hospital units or from Primary Care they find that databases are not integrated and information I not reachable. Therefore, when they want to get a complete overview of a patient they need to ask for different Consultation Requests and spend time and effort. Moreover whenever they aim to produce some feedback for other professionals they must fill several reports. It would be desirable to build an integrated HIS, which made information available for every actor involved in healthcare.

- Professionals loathe tedious and time-consuming tasks that reduce the time they spend in direct contact with patients. They feel they role as physicians is to treat patients rather than to make paperwork. They would like to dedicate longer to each of their patients. However, the inefficient current HIS, and the limited resources in the Service (that makes hiring support staff impossible) push them to shorten the length of visits. A robust HIS would reduce dramatically the time spent in paperwork and would allow professionals to expend more time with

patients, which may increase their commitment to disease management processes and their satisfaction on the service.

- Patients under the Integrated Care Program are evaluated periodically in order to inquire the evolution over time. In this sense, it would desirable that professionals had access to information on several subsequent visits in an only step, just inputting patient's medical record ID-number. Currently they must harvest data almost manually.

- Assessment scales are a useful tool to determine important features of patients (e.g. their risk of falling). These scales are obtained through the multi-folded assessment of patients, which generates large sets of data. Current information system does not support the automatic generation of risk factors or values in assessment scales. Therefore, it would be desirable to build a smart system that automatically gathered and evaluated the whole data set and generated a risk factor value without the intervention of a physician.

- In the integrated care model, professionals must move throughout different settings to give service to patients and to interact with professionals in other units. Moreover, they become 'multitask' and perform different activities within the integrated care program Thus, they face tight schedules and the administration of their agenda becomes difficult to handle. The Information System may incorporate an automatic calendar organizer that got inputs from administrative staff and from the professionals themselves and automatically let them know their schedule. Finally it may be also useful to determine the availability of professionals in a sudden and urgent situation.

- Further functionalities would be also interesting for the better functioning of the Integrated Care Program. The incorporation of a Decision Support System may ease the refinement of treatments and therapies and enable faster intervention. Besides, a platform for data analysis, with an interface to programs like R or SPSS would enhance their contribution to the research projects in the HUG's Research Foundation.

5 Design of a Health Information System

5.1 Personas

Dr María Sánchez's is a female 42-years-old Geriatrician at the University Hospital of Getafe. She graduated 18 years ago and completed her residency period at the HUG 13 years ago. She proved her worth, and the Head of the Service decided to hire her. Initially she worked at the Acute Care Unit, but she rapidly moved to the Community Care Unit. Last year, the physician in charge of the Falls and Fractures Clinic retired, and Dr Romero was offered the position. She is interested in frailty research, and this new job enabled her to be in closer contact with frail patients, so she accepted.

After her experience in the HUG she knows perfectly the service and the integrated care program. Moreover she supports it actively and collaborates continuously with the Research Foundation and the engineers in the eHealth Unit, in order to translate new findings to regular activity and improve care delivery. She is willing to work in multidisciplinary teams and integrate with different units at different levels, as she feels it empowers professionals with a comprehensive view of the case. Besides, she supports dynamic evolution assessment of functional status instead of a still-photograph approach. Finally she does not have any constraint to work with technology.

Although María loves her job and commits to the good functioning of the integrated program, its work often overwhelms her. She spends much time dealing with information, which often impedes her from dedicating longer time to her patients. In this sense María feels that there is the need for a big change, and she has developed some frustrations that are affecting her psychological status and her commitment to the service:

María is aware that a more powerful Health Information System would have a great impact on her activity as physician. Besides she would like to find it in a usable and handy solution. Currently she can interact with the HIS through the VPN located in her office, so data collection must be performed on paper, which is incompatible with complete efficiency: handwriting may be illegible, papers may be lost and data may be wrongly written down, etc. María would like to use a dedicated tablet application that allowed her to carry the input terminal while working and guided her on the Comprehensive Geriatric Assessment, thus making data collection safer and more comfortable.

5.2 Scenario

As every morning, María gets to the Hospital at 7.55 a.m. She faces a hard work day ahead, but she is full of energy and willingness. First of all she checks her timetable, and she finds she has an appointment at 8.00 with Julio, a 76-years-old recurrent faller she manages. She takes her tablet and searches Julio's Medical Record. She gets an overview of Julio's current status and reads the last comments by Julio's General Practitioner. Then, she meets Julio and his daughter. She

opens the 'EasyGeriAssess' application, that guides her over the Comprehensive Geriatrics Assessment, and empowers her to input data in real time. After completing all the trials and automatically getting Julio's risk factors, María prepares a report for the Occupational Therapist at the Day Hospital and for Julio's General Practitioner. Then, she receives that an appointment for Julio's next visit has been made by the automatic calendar in the HIS.

During the coffee break, María receives an alert on her tablet. A colleague from the Neurology Unit has modified the pharmacological therapy of María, one of her 85-years-old potential fallers who also suffers from Alzheimer. However, the Decision Support System in the HIS has alerted him. The inclusion of that drug in the polypharmaceutical treatment of the patient may affect his proprioceptive abilities and lead to a fall. María evaluates the pros and cons of the drug mixture and authorises the modification: in the particular case of that patient the drug will not be dangerous.

At 11 a.m. María holds a meeting with the Occupational Therapist working at the Day Hospital. She has read Julio's report and they discuss whether it would be appropriate to increase the gait speed in Julio's equilibrium exercises. They check Julio's evolution in the HIS and they decide to keep the same strategy for now- They will cope that issue when the posturography results show better trends.

At 12:15 p.m. María receives an alert. A potential faller has undergone a second fall within 9 months in his Nursing Home. Although the fall has not produces any concerning consequence, the patient now fulfils the criteria to be included in the integrated care program. She produces a feedback report with some recommendations for nursing home professionals and includes the patient in the top priority appointment waiting list. 10 minutes later the system lets her know that the patient will visit her next week.

After lunch she moves to the Research Foundation at the Hospital. She is participating in ACANTO, a European Project in the Horizon 2020 framework, which intends to develop a smart walker for the assistance of elderly patients both in their daily life activity and in the training sessions at Day Hospital. María retrieves the SPPB (Short Physical Performance Battery) and gait-speed values for her patients in the 70 to 80-year-old age group (group of interests). Moreover she downloads information on the intake doses of different drugs by those patients, including Donepezilo for Dementia, some hypotensors like Enalapril or Torasemide, and Antidiabetic medication such as Glicazide or Metformin. María and her engineer colleagues inquire the effect of polypharmacy on both physical parameters. They take advantage of the structured format of data in the HIS and easily analyse data in SPSS and derive that SPPB is mostly affected by Hypotensors, while the combination of all drugs affects slightly the gait-speed velocity, although correlation is not robust enough to consider it a definite factor.

After the discussion of these outcomes and their implications, María finishes her working day and goes back home to rest.

5.3 Information Scenario

As already explained information availability is crucial for integration. Professionals should find a system which allowed them to retrieve the information they want in the easiest and most accurate way. Moreover this information should be reachable whenever the professional needed it and present both updated data and the evolution of parameters over time.

During the designing process I realized that there exist two non-integrated information sources for the professionals performing the integrated care program. On the one hand, Comprehensive Evaluation of patients requires many different diagnostic trials and the storage of large sets of data depicting the evolution of patients. Thus, dedicated databases have been created for the storage and analysis of patients' status. These databases include heterogeneous parameters and are blind to the rest. On the other hand, data from patients, professionals and these related to administrative and managerial issues are stored on the HUG's general Health Information System. Currently these two information sources are not any interface between them. This situation hinders remarkably integration, as professionals are pushed to use informal pathways every time they need to use information from either one of them.

In this sense, the new HIS would be established over a relational database which comprises interconnected data tables or 'entities'. The link between these data tables would be some 'key' variables or 'relations' between tables. Thus, all the information input in some table in the database would be retrievable calling any other. Some of these data tables (the green in the figure below) will be exclusive for the Geriatric Service, while others (the yellow ones in the figure) will become the link between the Service-dedicated data tables and the HUG's general Health Information System.

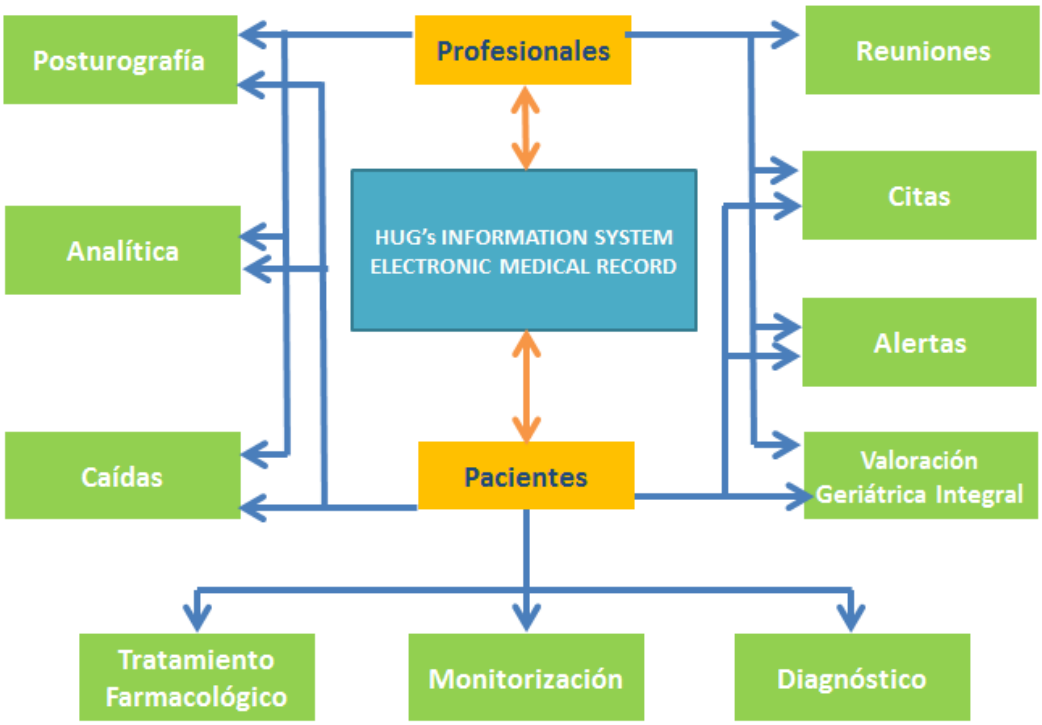


Figure 11 Information Pathways in the improved Health Information System

5.4 Design of user interaction

User-interface design was developed after the study of current Hospital application software and the development of further functionalities. I performed this analysis together with specialists from the Geriatrics Service and the Head of the IT Department at the Hospital. The following navigation map describes the main pathways users may follow within the system. This mock-up was presented to the users to draw the evaluation results.

Every user will access the system from local VPNs in the hospital. Moreover, some professionals would be provided with tablets which will empower them to input and withdraw information using a portable device. Portability would be useful especially for those professionals performing Comprehensive Geriatric Evaluation trials on patients. The complete VGI comprises different trials in different rooms and facilities in the Hospital. Thus, professionals must escort patients through the complete evaluation process and, at the same time, collect data. A handy device like a small tablet or PDA would ease their tasks remarkably.

Users must turn on the device and they find a **Welcome Screen** with regular user and password sign in form. They should use their professional number and password in the HUG's HIS to prove their identity. Once they log in, they are driven to their **Personal Dashboard or Home Page**. In this screen they may find the main alerts in the Geriatrics Service and the upcoming events in their agenda. Furthermore the screen poses different options for professionals. There is a patient search engine available, which leads them to **Patient Dashboard**, where they can input or retrieve information on patients, and get an extensive overview of patient status and situation within health care pathways in the Service. Besides, other functionalities are reachable from the professional's dashboard. Professionals may check their **Agenda** and the one for the Service. Besides they may have a look at the **Notifications** of events in the Service and the access the profile of the affected patient. Nevertheless the system would not only be a consultation tool but also incorporates tools for the generation of information. For instance, it will comprise a supportive tool for the performance of the

Comprehensive Geriatric Evaluation of patients, which will incorporate data to patient's Electronic Medical Record. After completing all the trials professionals may check patient evolution and generate a **notification** whenever a remarkable event is monitored or just **report** the outcomes of the visit into patient's history. Besides, the system would analyse the generated data and would automatically reassess patient classification. Apart the system may also incorporate a **Decision Support System** for professionals, suggesting clinical pathways and treatments, although the final resolution is always made by the specialist. Finally, they have the option to create a **New Patient** profile whenever they manage a patient for the first time.

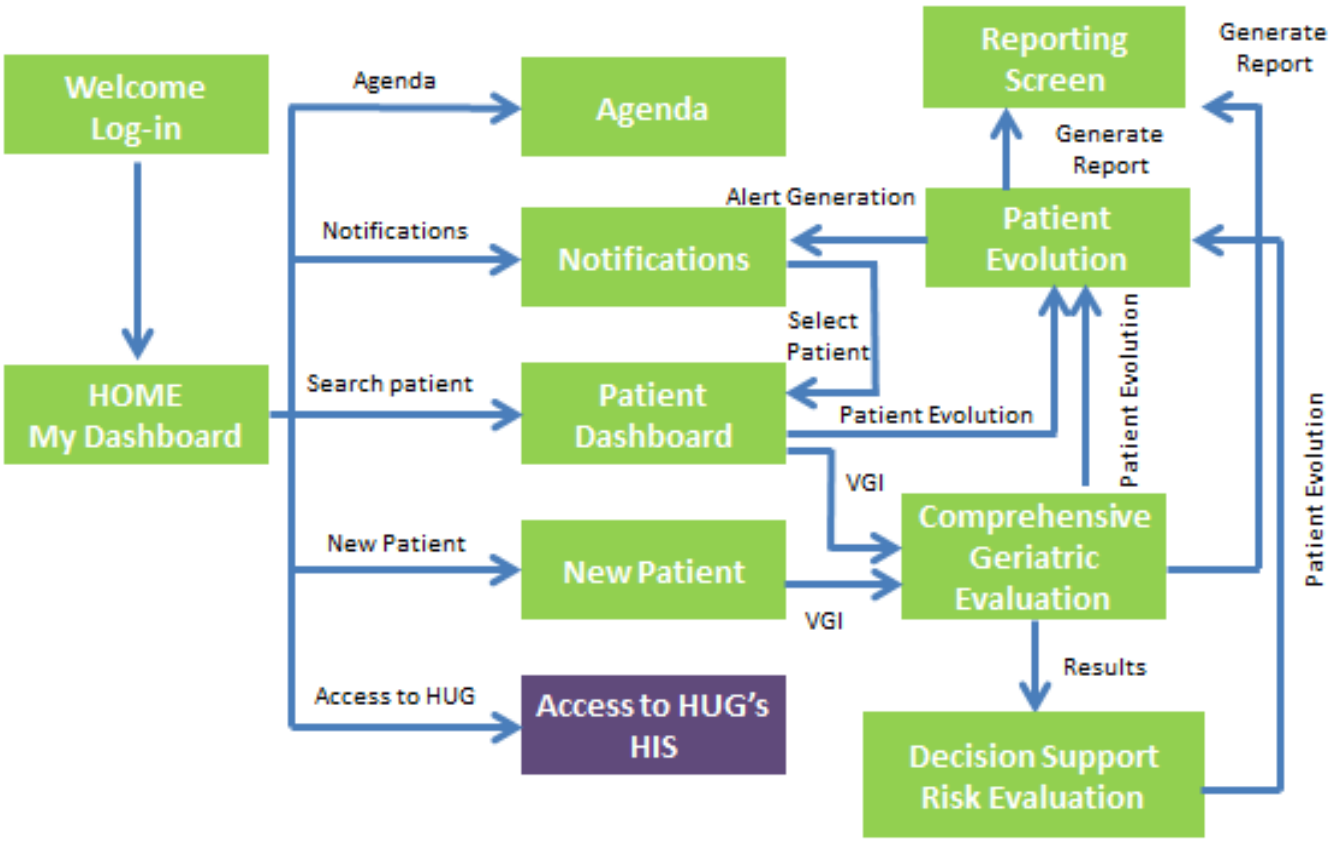
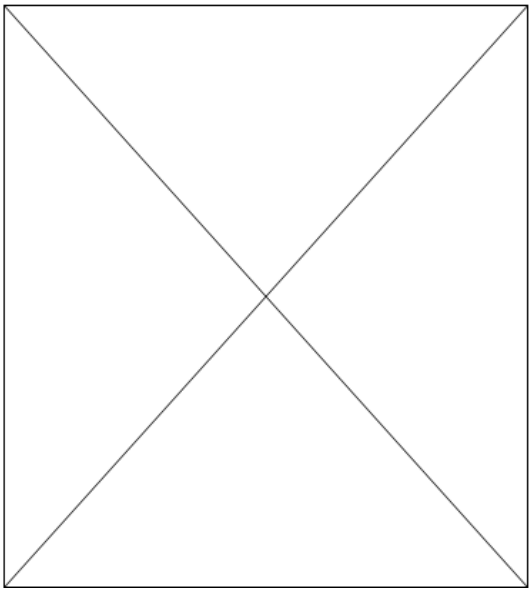


Figure 12 System Navigation Map

The following figures depict some of the screen in the system. In some cases two different versions are presented. The first is the one I developed after the analysis of the context of the Geriatrics Service. The second one is the result of the refinement suggested by professionals wherein new functional blocks were included, while some others were removed. Moreover the presentation of information was reorganized meeting the desires of specialists.



Valoración geriátrica

Servicio de Geriatría

Hospital Universitario de Getafe

Número de identificación

Contraseña

¿Has olvidado tu contraseña?

Entrar

Figure 13 Welcome screen and log in

Valoración Geriártrica - HUG

María Sánchez HUG

Pacientes

Nuevo Paciente | Buscar paciente (por NHC o apellidos) | Buscar

Fecha	Paciente	Notificación	
16/06/15	Carmen Rojas	Ingreso en urgencias	1
17/06/15	Faustina Rodríguez	Ingreso por caída	1
17/06/15	María Rodríguez	Ingreso por problemas ...	1
16/06/15	Carmen Sancho	PIC Neurología	2
17/06/15	María Luisa Ascó	PIC Traumatología	2
17/06/15	Rogelio Abadía	Cambio tratamiento	2
17/06/15	Manuela Bonete	PIC Médico Primaria	2
17/06/15	Fabián Marcel	Resultados Analítica	
17/06/15	Luis Carandell	Resultados Analítica	
17/06/15	Marcela Rubio	Resultados Analítica	

Mostrando 10 de 14 Siguientes >>

Citas

Nuevo evento

17 06 15

Tienes 10 eventos

10:00
Cita Médica
Marcelina Barrios

10:20
Cita Médica
Joaquín Martínez-Podio

10:40
Cita Médica
Gloria López

Ir al calendario

Figure 14 Home page/dashboard. First Version

Figure 15 Home page/dashboard. Second version

The information appearing in the dashboard was modified to meet the demands of Geriatricians. The information (notifications, events) I initially considered were not the most useful for physicians. They preferred information on patients' status and health changes rather on administrative issues. Therefore the kind of notifications they would get in the first screen was amended.

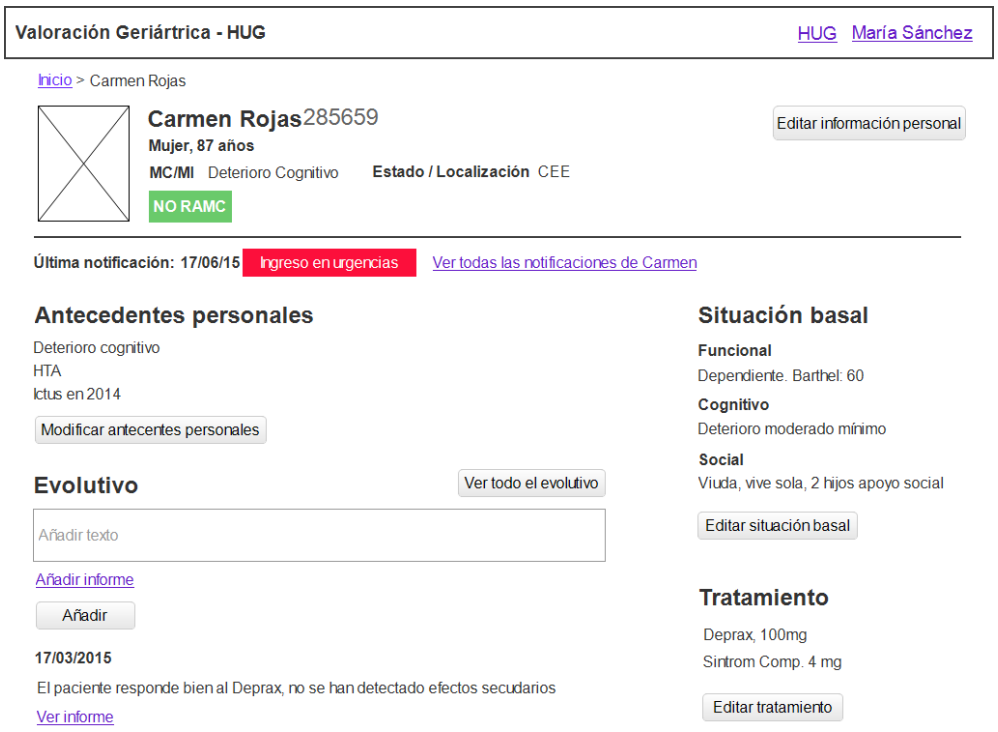


Figure 16 Patient profile. First version.

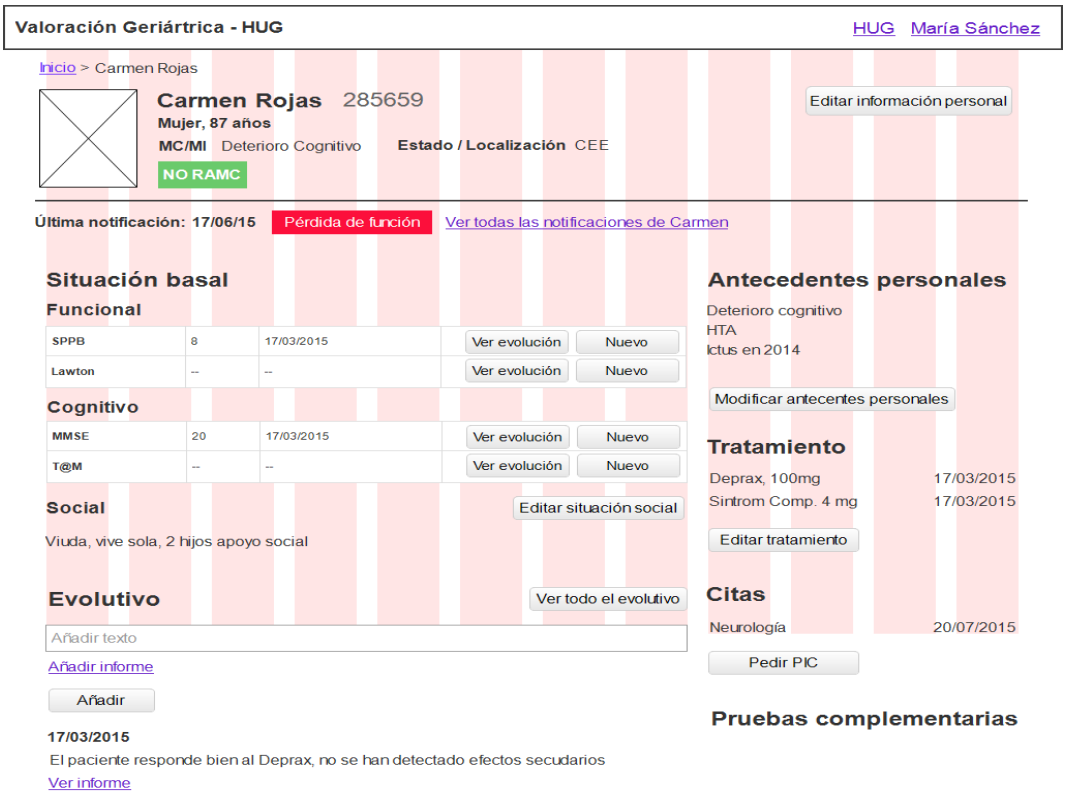


Figure 17 Patient profile. Second version.

The main differences between the two versions of the patient profile screen are related to the organisation of information. Physician asked for the inclusion of some indices which are relevant for the determination of patients' baseline situation, like Lawton and Barthel.

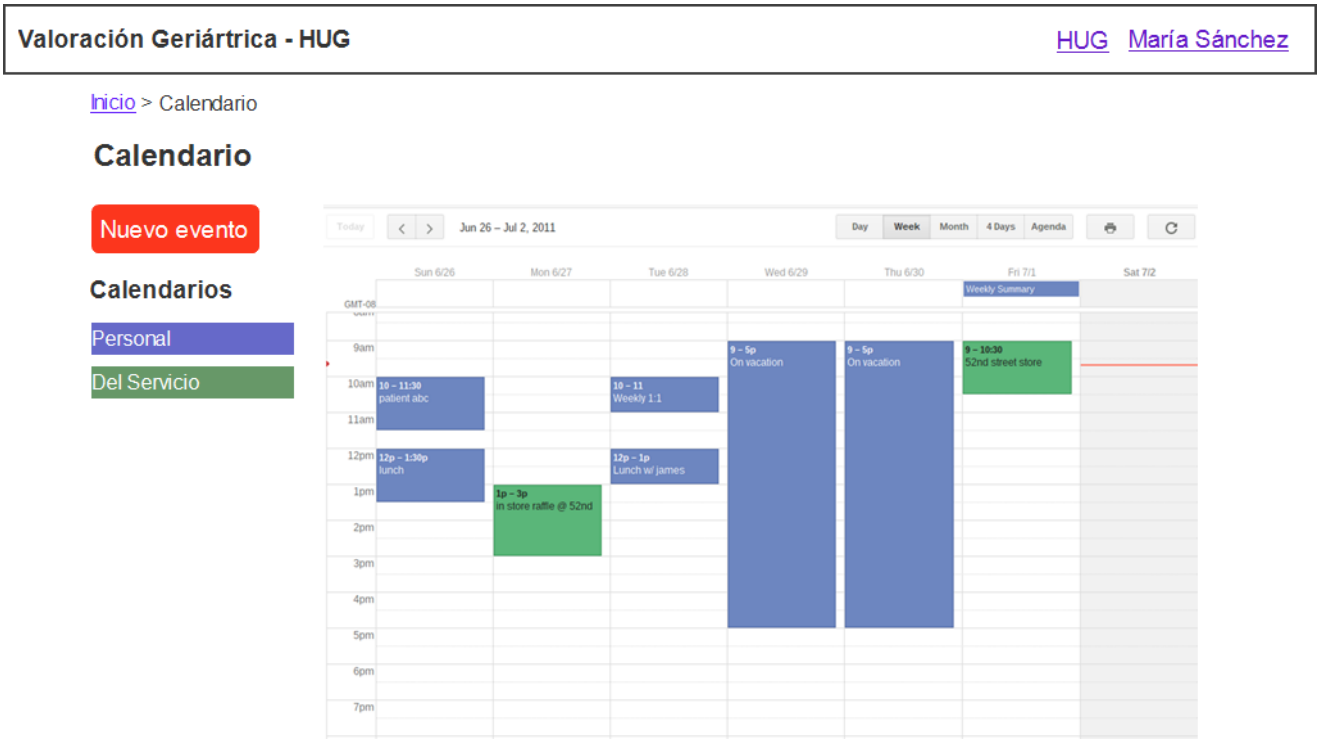


Figure 18 Agenda screenshot

Finally, the calendar screen allows professionals to know the programmed activities they have during the week and those held by the Geriatrics Service in general.

6 Evaluation of the health information system

As already explained the model for the HIS system was evaluated by two different means. First of all formative evaluation was performed over the whole development process. Nonetheless, despite the benefits for the designing process, this evaluation strategy does not produce any tangible outcome. Contrarily, summative evaluation can be carried out over questionnaires delivered to users, and quantitative measurements can be used to characterize the quality of our system after the complete development of the prototype.

I the particular case of the HIS model I used two questionnaires to inquire the usability of the system (SUS questionnaire) and user's perception on the system (UEQ). 4 physicians participated in the study and the following results were obtained:

System Usability Scale					
User	Dr. Gonzales	Dr. Checa	Dra. Castro	Dr. Laosa	**TOTAL**
Score	82	80	80	82	**81**

Table 8 SUS evaluation results

The average value obtained in the SUS questionnaire was 81. Taking into account that values over 68 in a 0-100 scale are considered to be satisfactory, I can say that **my system is usable**, at least for those who will benefit from it.

Regarding user experience results were also promising. The perception of users in the system was excellent in every item in the study. I can support that users would be willing and able to adopt the extended HIS.

UEQ means per person						
	Attarctiveness	**Perspicuity**	**Efficiency**	**Dependability**	**Stimulation**	**Novelty**
Dr Castro	1,33	2,00	2,00	2,00	1,00	0,75
Dr Laosa	2,00	1,75	2,25	2,00	2,75	2,75
Dr Checa	2,17	2,25	1,00	2,25	1,75	2,00
Dr Gonzales	1,67	2,00	1,00	2,25	1,50	1,25

Table 9UEQ scores for each of the six items covered

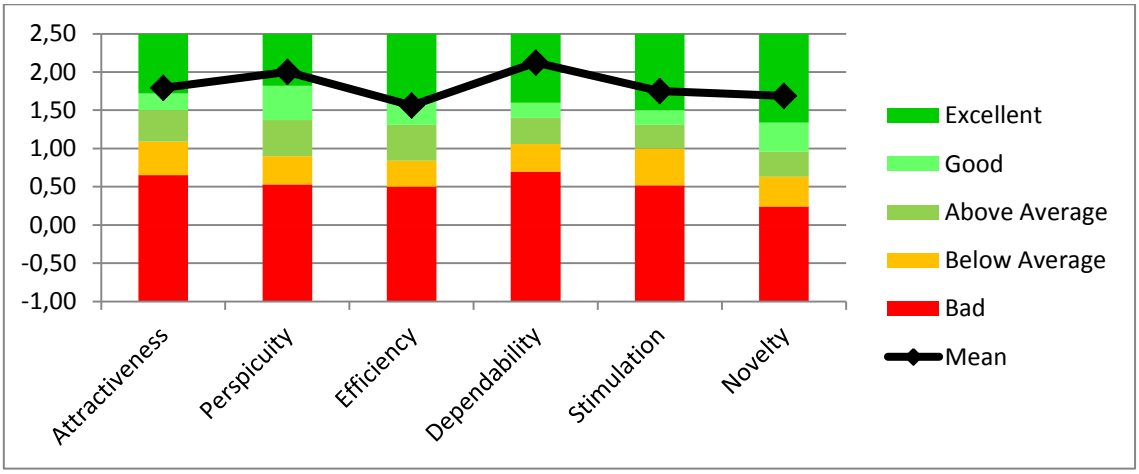


Figure 19 System evaluation with respect to the benchmark

7 Conclusions

The evaluation outcomes are promising. The system is usable and professionals feel comfortable and confident while dealing with it. They value especially the innovative spirit, the perspicuity and the controllability of the system with respect to the current approach. Besides, the research process associated to my Bachelor Thesis has been successful. All stages and goals have been accomplished:

- I analysed the system in the deepest way, immersing myself in the system and acquiring a complete knowledge of how the Geriatrics Service is structured, managed and operated In particular I understood the motivations for the implementation of an integrated care model and how difficult it may be to achieve complete coordination.
- I interacted directly with users and got their engagement in the process. They actively participated in the design of the Information System, and their contribution was crucial to enhance the suitability of the system to the real needs, requirements and features of the Geriatrics Service.
- I developed robust and meaningful scenarios, which eased the development of the different components in the HIS. Besides, they provided our collaborators with a closer idea to the aim of my project. They are a highly descriptive method to orientate research and to share with other actors which is the target of your design.
- I designed a complete and usable health information system. Data structure and management is compatible with the activity of the Geriatrics Service. It does not disrupt pre-established Disease Management Processes but adapt to them. Professionals from the Service appreciated especially the small effort they would have to make to work with the new system.
- I developed Me-Fi prototypes that mimic the interaction model professionals would face while using the new system. Moreover this mock-up enabled the validation of my system, the main goal of this research.

Besides, there are several outcomes that may be derived from this project. Currently, healthcare delivery quality standards are compromised by the limited resources available. Workforce is reduced to the minimum and professionals are pushed to treat as many patients as possible which may reduce expenditure at first hand, but sometimes is often incompatible with efficiency. Integration of services appears as one potential solution to the unbalance in public healthcare systems. However, the pathways leading to it are intricate, and the environment of application may determine the success of the initiatives.

The HUG has tried to implement an integrated care program for the management of complex and functionally impaired patients. The model has proven to be cost-saving for the Geriatrics Service and beneficial for clients. However, it has increased the workload on professionals, who have to deal with paperwork and large amounts of data. Somehow the technological environment has evolved slower than new clinical approaches. Although the Service has created some databases for the management of data, these are not interoperable with the HUG's Information System. Therefore

information exchange with other Services is carried out in an informal way. Finally, this lack of communication pathways triggers adverse events, as devised services are not delivered in an efficient way.

The designed Information System is based on a relational database which will be exclusive available in the Geriatrics Service. It was designed specifically to meet the requirements of the integrated care program (e.g. functional assessment of patients). This specificity may hinder the transferability to other systems, although dedicated information systems may be implemented in other Services after the analysis of their features and demands. Nevertheless, the Geriatrics HIS would not be isolated from the rest of information infrastructure in the Hospital. The main advantage of my system is that it covers the features found exclusively in the integrated care program but is also interoperable with the HUG's HIS. Moreover it aims to enhance the information exchange within the system, creating a dynamic platform for the fastest and most appropriate intervention of professionals only when it is needed, refining Disease Management Processes. Finally, the new system would allow the collection of data in a single system, avoiding the duplication in two different Information hubs.

From the financial point of view, the implementation of the system would receive support from the Head of Geriatrics Service and the head of the IT Department at the HUG. The Geriatrics Service manages its own assets. Thus, the savings arising from the integrated care program may be reinvested on the new HIS. Besides, the IT Department owns research and innovation funds that may be dedicated to the improvement of the Information network.

Summarizing, integration must be devised to make healthcare more efficient and rational. ICT are the most promising tool in this sense as they enable the smooth modification of current clinical pathways. Information availability empower professionals to manage, diagnose and treat their patients remotely, and to get complete, meaningful and reliable data for the evaluation of risk and the development of preventive and proactive therapies.

8 Budget for the Bachelor Thesis

- I include the expenses on computing systems dedicated to the development of the HIS.

Computer	Price of one item	Amortization	Usage	Total
PC Acer Aspire	€600	3 years	6 months	€100

- I employed the Justinmind software for the creation of the HIS prototype

Computer program	Price per month	Usage	Total
Justinmind Prototyper	€25	2 months	€50

- I adjusted the salary to that of a junior engineer without experience. The gross salary would be around €25000/year

Worker	Gross Salary per month	Period	Total
Biomedical Engineer	€2083.33	6 months	€12500

TOTAL COST OF THE PROJECT: Twelve thousand six hundred fifty euros (12650€)

9 Annex

9.1 Scales and measurements in Geriatrics

9.1.1 Basal status: comorbidities

9.1.1.1 Charlson index

The Charlson Comorbidity Index is a method of categorizing comorbidities of patients based on the International Classification of Diseases (ICD) diagnosis codes found in administrative data, such as hospital discharge abstracts data. Each comorbidity category has an associated weight, based on the adjusted risk of mortality or resource use, and the sum of all the weights results in a single comorbidity score for a patient. A score of zero indicates that no comorbidities were found. The higher the score, the more likely the predicted outcome will result in mortality or higher resource use.

Table 1. Charlson Comorbidity Index Scoring System

Score	Condition
1	Myocardial infarction (history, not ECG changes only)
	Congestive heart failure
	Peripheral vascular disease (includes aortic aneurysm ≥6 cm)
	Cerebrovascular disease: CVA with mild or no residua or TIA
	Dementia
	Chronic pulmonary disease
	Connective tissue disease
	Peptic ulcer disease
	Mild liver disease (without portal hypertension, includes chronic hepatitis)
	Diabetes without end-organ damage (excludes diet-controlled alone)
2	Hemiplegia
	Moderate or severe renal disease
	Diabetes with end-organ damage (retinopathy, neuropathy, nephropathy, or brittle diabetes)
	Tumor without metastases (exclude if >5 y from diagnosis)
	Leukemia (acute or chronic)
	Lymphoma
3	Moderate or severe liver disease
6	Metastatic solid tumor
	AIDS (not just HIV positive)

NOTE. For each decade > 40 years of age, a score of 1 is added to the above score.
Abbreviations: ECG, electrocardiogram; CVA, cerebrovascular accident; TIA, transient ischemic attack; AIDS, acquired immunodeficiency syndrome; HIV, human immunodeficiency virus.

9.1.2 Frailty scales

9.1.2.1 Linda Fried Criteria

1- Weight loss:

We have to ask the patient if he or she has lost weight unintentionally in the past year, and if the loss was greater than 4,5 kg (10 lb).

YES	(1)
NO	(0)

2- Exhaustion

- "I felt that everything I did was an effort during the past week"
- I could not get "going":

  If SOME (OR BOTH) answers are YES, one point (1) for frailty will be counted.

3- ***Physical activity:*** Does the patient perform less than or equal to the physical activity indicated weekly?

Men	< 383 kcal / week (walking ≤ 2 hours and30 minutes / week)
Woman	< 270 kcal / week (walking ≤ 2 hours / week)

We ask the patient to respond with YES or NO if he/she performs these activities. If they answer YES, one point for frailty will be counted.

4- ***Slowness:*** Measured as the time it takes for the patient to travel 15 feet to their usual walking speed.

SEX	Height(CM)	CUT OFF
MEN	≤173 cm	≥7s
	>173 cm	≥6s
WOMEN	≤159 cm	≥7s
	>159 cm	≥6s

This is done as follows: we will indicate to the patient to stand immediately behind the starting line, we will tell him/her to start walking "as he/she usually does". The patient is then stopped. We will do the test twice and we will take the best score of the two. The time will be recorded in seconds.

5- **Weakness:** Assessed by grip strength.

BMI	♂CUT OFF	BMI	♀CUTOFF
≤ 24	<29 kg	≤23	<17kg
24,1-24.	<30 kg	23,1-26	<17,3kg
26,1-28	<30 kg	26,1-29	<18kg
> 28	<32 kg	>29	<21 kg

He/she will rest for about 30 seconds, and he/she will repeat the exercise two more times. We will record the best of all results.

SCORE:

Robust: 0, Pre - Frailty: one or two of the criteria, Frailty: Three or more.

9.1.2.2 FRAIL Scale:

1.- **Fatigue** is measured by asking respondents how much time during the past 4 weeks they have felt tired. With responses of "all of the time" or "most of the time" scored as 1 point.

2.- **Resistance** is assessed by asking participants if they have had any difficulty walking up 10 steps alone without resting and without aids: a yes response is scored as 1 point.

3.- **Ambulation** is assessed by asking if they had any difficulty walking several hundred meters alone and without aids: a yes response is scored as 1 point.

4.- **Illness** is scored 1 for respondents who report 5 or more illnesses out of 11 total illnesses:(hypertension, diabetes, cancer (other than a minor skin cancer),chronic lung disease, heart attack, congestive heart failure, angina, asthma, arthritis, stroke, and kidney disease).

5.- **Loss of weight** is scored 1 for respondents with a weight decline of 5 % or greater within the past 12 months based on self-report.

SCORE:

Robust: 0, Pre - Frailty: one or two of the criteria, Frailty: Three or more.

9.1.3 Functional scales

9.1.3.1 Barthel Index (Basic activities of daily living)

Feeding 0 = unable 5 = needs help cutting, spreading butter, etc., or requires modified diet 10 = independent	☐ ☐ ☐ 0 5 10
Bathing 0 = dependent 5 = independent (or in shower)	☐ ☐ 0 5

Grooming 0 = needs to help with personal care 5 = independent face/hair/teeth/shaving (implements provided)	☐ ☐ 0 5
Dressing 0 = dependent 5 = needs help but can do about half unaided 10 = independent (including buttons, zips, laces)	☐ ☐ ☐ 0 5 10
Bowels 0 = incontinent (or needs to be given enemas) 5 = occasionalaccident 10 = continent	☐ ☐ ☐ 0 5 10
Bladder 0 = incontinent, or catheterized and unable to manage alone 5 = occasionalaccident 10 = continent	☐ ☐ ☐ 0 5 10
Toilet Use 0 = dependent 5 = needs help, but can do something alone 10 = independent (on and off, dressing, wiping)	☐ ☐ ☐ 0 5 10
Transfers (bed to chair and back) 0 = unable, no sitting balance 5 = major help (one/two people,physical), can sit 10 = minor help (verbal or physical)	☐ ☐ ☐ ☐ 0 5 10 15

15 = independent	
Mobility (on level surfaces) 0 = immobile or < 50 yards 5 = wheelchair independent (inc.corners)>50 yds 10 = walks with help of one person (verbal or physical) > 50 yards 15 = independent (but may use any aid; for example, stick) > 50 yards	☐ 0 ☐ 5 ☐ 10 ☐ 15 ☐
Stairs 0 = unable 5 = needs help (verbal, physical, carrying aid) 10 = independent	☐ 0 ☐ 5 ☐ 10 ☐
TOTAL (0-100)	

SCORE:

0-20 indicate "total" dependency

21-60 indicate "severe" dependency

61-90 indicate "moderate" dependency

91-99 indicates "slight" dependency

100 "Independent

9.1.3.2 Lawton Index (Instrumental activities of daily living scale)

The Lawton Instrumental Activities of Daily Living Scale

A. Ability to Use Telephone

1. Operates telephone on own initiative; looks up and dials numbers 1
2. Dials a few well-known numbers 1
3. Answers telephone, but does not dial 1
4. Does not use telephone at all 0

B. Shopping

1. Takes care of all shopping needs independently 1
2. Shops independently for small purchases 0
3. Needs to be accompanied on any shopping trip 0
4. Completely unable to shop 0

C. Food Preparation

1. Plans, prepares, and serves adequate meals independently 1
2. Prepares adequate meals if supplied with ingredients 0
3. Heats and serves prepared meals or prepares meals but does not maintain adequate diet 0
4. Needs to have meals prepared and served 0

D. Housekeeping

1. Maintains house alone with occasion assistance (heavy work) 1
2. Performs light daily tasks such as dishwashing, bed making 1
3. Performs light daily tasks, but cannot maintain acceptable level of cleanliness 1
4. Needs help with all home maintenance tasks 1
5. Does not participate in any housekeeping tasks 0

E. Laundry

1. Does personal laundry completely .....
2. Launders small items, rinses socks, stockings, etc. ....
3. All laundry must be done by others .....

F. Mode of Transportation

1. Travels independently on public transportation or drives own car .....
2. Arranges own travel via taxi, but does not otherwise use public transportation .....
3. Travels on public transportation when assisted or accompanied by another .....
4. Travel limited to taxi or automobile with assistance of another .....
5. Does not travel at all .....

G. Responsibility for Own Medications

1. Is responsible for taking medication in correct dosages at correct time .....
2. Takes responsibility if medication is prepared in advance in separate dosages .....
3. Is not capable of dispensing own medication .....

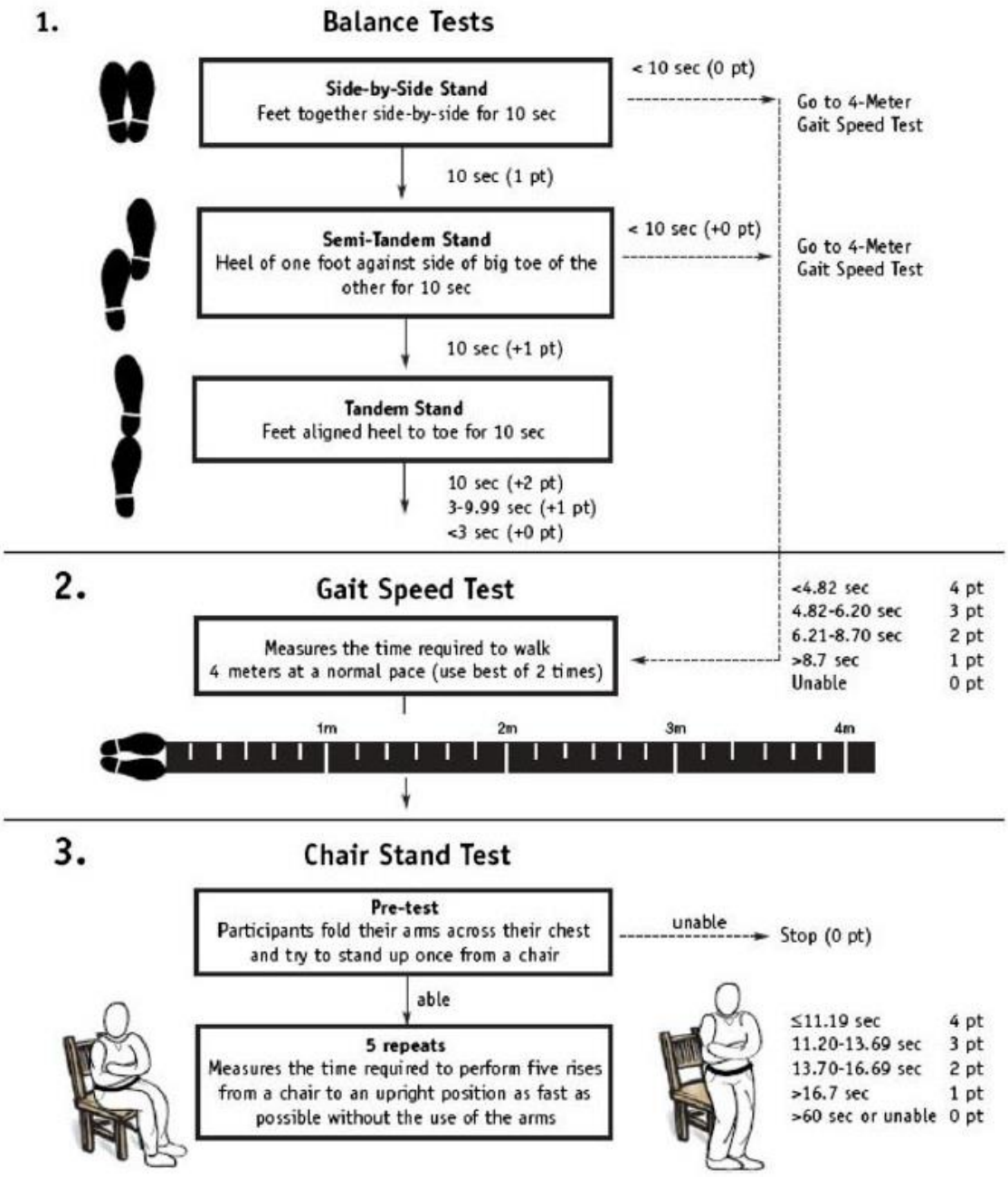
H. Ability to Handle Finances

1. Manages financial matters independently (budgets writes checks, pays rent and bills, goes to bank); collects and keeps track of income .....
2. Manages day-to-day purchases, but needs help with banking, major purchases, etc .....
3. Incapable of handling money .....

Scoring: For each category, circle the item description that most closely resembles the client's highest functional level (either 0 or 1).

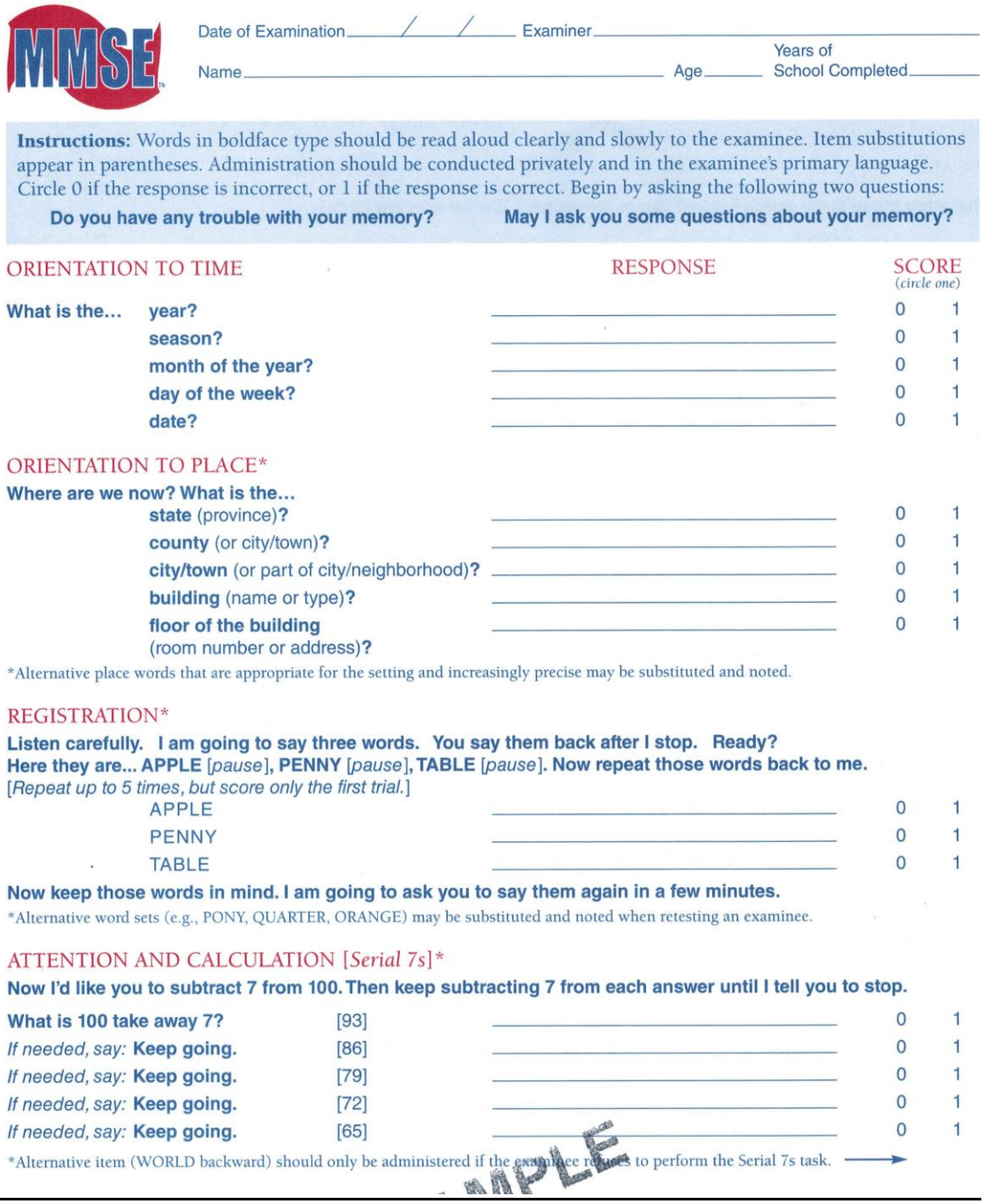
Lawton, M.P., & Brody, E.M. (1969). Assessment of older people: Self-maintaining and instrumental activities of daily living. *The Gerontologist, 9*(3), 179-186.

9.1.3.3 Short Physical Performance Battery (SPPB)



9.1.4 Mental status

9.1.4.1 Mini-mental state examination (MMSE)



MMSE

Date of Examination ___/___/___ Examiner _____

Name _____ Age ____ Years of School Completed ____

Instructions: Words in boldface type should be read aloud clearly and slowly to the examinee. Item substitutions appear in parentheses. Administration should be conducted privately and in the examinee's primary language. Circle 0 if the response is incorrect, or 1 if the response is correct. Begin by asking the following two questions:

Do you have any trouble with your memory? **May I ask you some questions about your memory?**

ORIENTATION TO TIME		RESPONSE	SCORE (circle one)
What is the...	**year?**		0 1
	season?		0 1
	month of the year?		0 1
	day of the week?		0 1
	date?		0 1

ORIENTATION TO PLACE*

Where are we now? What is the...

state (province)**?**		0 1
county (or city/town)**?**		0 1
city/town (or part of city/neighborhood)**?**		0 1
building (name or type)**?**		0 1
floor of the building (room number or address)**?**		0 1

*Alternative place words that are appropriate for the setting and increasingly precise may be substituted and noted.

REGISTRATION*

Listen carefully. I am going to say three words. You say them back after I stop. Ready? Here they are... APPLE [*pause*], **PENNY** [*pause*], **TABLE** [*pause*]. **Now repeat those words back to me.**
[*Repeat up to 5 times, but score only the first trial.*]

APPLE		0 1
PENNY		0 1
TABLE		0 1

Now keep those words in mind. I am going to ask you to say them again in a few minutes.

*Alternative word sets (e.g., PONY, QUARTER, ORANGE) may be substituted and noted when retesting an examinee.

ATTENTION AND CALCULATION [*Serial 7s*]*

Now I'd like you to subtract 7 from 100. Then keep subtracting 7 from each answer until I tell you to stop.

What is 100 take away 7?	[93]		0 1
If needed, say: **Keep going.**	[86]		0 1
If needed, say: **Keep going.**	[79]		0 1
If needed, say: **Keep going.**	[72]		0 1
If needed, say: **Keep going.**	[65]		0 1

*Alternative item (WORLD backward) should only be administered if the examinee refuses to perform the Serial 7s task. →

CLOSE YOUR EYES

9.1.4.2 Geriatric Depression Scale (GDS)

Geriatric Depression Scale: Short Form

Choose the best answer for how you have felt over the past week:

1. Are you basically satisfied with your life? YES / **NO**
2. Have you dropped many of your activities and interests? **YES** / NO
3. Do you feel that your life is empty? **YES** / NO
4. Do you often get bored? **YES** / NO
5. Are you in good spirits most of the time? YES / **NO**
6. Are you afraid that something bad is going to happen to you? **YES** / NO
7. Do you feel happy most of the time? YES / **NO**
8. Do you often feel helpless? **YES** / NO
9. Do you prefer to stay at home, rather than going out and doing new things? **YES** / NO
10. Do you feel you have more problems with memory than most? **YES** / NO
11. Do you think it is wonderful to be alive now? YES / **NO**
12. Do you feel pretty worthless the way you are now? **YES** / NO
13. Do you feel full of energy? YES / **NO**
14. Do you feel that your situation is hopeless? **YES** / NO
15. Do you think that most people are better off than you are? **YES** / NO

Answers in **bold** indicate depression. Score 1 point for each bolded answer.

A score > 5 points is suggestive of depression.
A score ≥ 10 points is almost always indicative of depression.
A score > 5 points should warrant a follow-up comprehensive assessment.

9.1.5 Quality of life

9.1.5.1 EuroQL 5D 5L

Under each heading, please tick the ONE box that best describes your health TODAY

Mobility *(walking about)*

I have no problems walking about ❑
I have some problems walking about ❑
I have a lot of problems walking about ❑

Looking after myself

I have no problems washing or dressing myself ❑
I have some problems washing or dressing myself ❑
I have a lot of problems washing or dressing myself ❑

Doing usual activities *(for example, going to school, hobbies, sports, playing, doing things with family or friends)*

I have no problems doing my usual activities ❑
I have some problems doing my usual activities ❑
I have a lot of problems doing my usual activities ❑

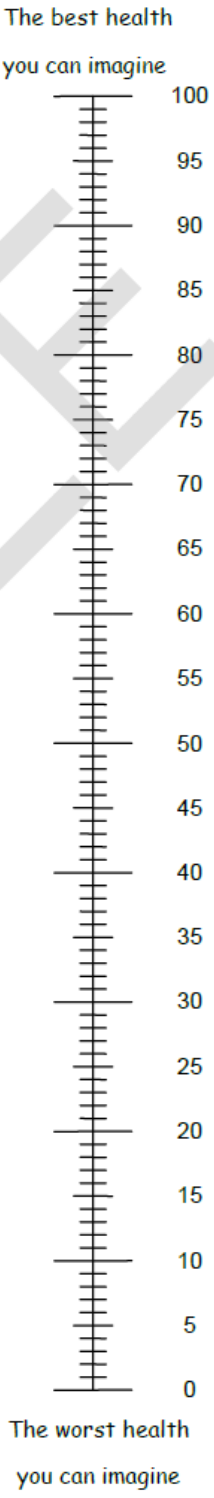
Having pain or discomfort

I have no pain or discomfort ❑
I have some pain or discomfort ❑
I have a lot of pain or discomfort ❑

Feeling worried, sad or unhappy

I am not worried, sad or unhappy ❑
I am a bit worried, sad or unhappy ❑
I am very worried, sad or unhappy ❑

How good is your health TODAY



- We would like to know how good or bad your health is TODAY.
- This line is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Please mark an X on the line that shows how good or bad your health is TODAY.

9.2 System Usability Scale

	Spanish Version (the one employed)	**English Version**
1	Creo que me gustará usar con frecuencia este sistema	I think that I would like to use this system frequently.
2	Encontré el sistema innecesariamente complejo	I found the system unnecessarily complex.
3	Pienso que el sistema es fácil de usar	I thought the system was easy to use.
4	Creo que necesitaría apoyo de un experto para utilizar el sistema	I think that I would need the support of a technical person to be able to use this system.
5	Encontré las diversas posibilidades del sistema bastante bien integradas	I found the various functions in this system were well integrated.
6	Pienso que hay demasiada inconsistencia en el sistema	I thought there was too much inconsistency in this system.
7	Creo que la mayoría de la gente podría hacer uso del sistema rápidamente	I would imagine that most people would learn to use this system very quickly.
8	He encontrado el sistema bastante incómodo de utilizar	I found the system very cumbersome to use.
9	Me he sentido muy seguro haciendo uso del sistema	I felt very confident using the system.
10	Necesitaría aprender muchas cosas antes de poder utilizar el sistema	I needed to learn a lot of things before I could get going with this system

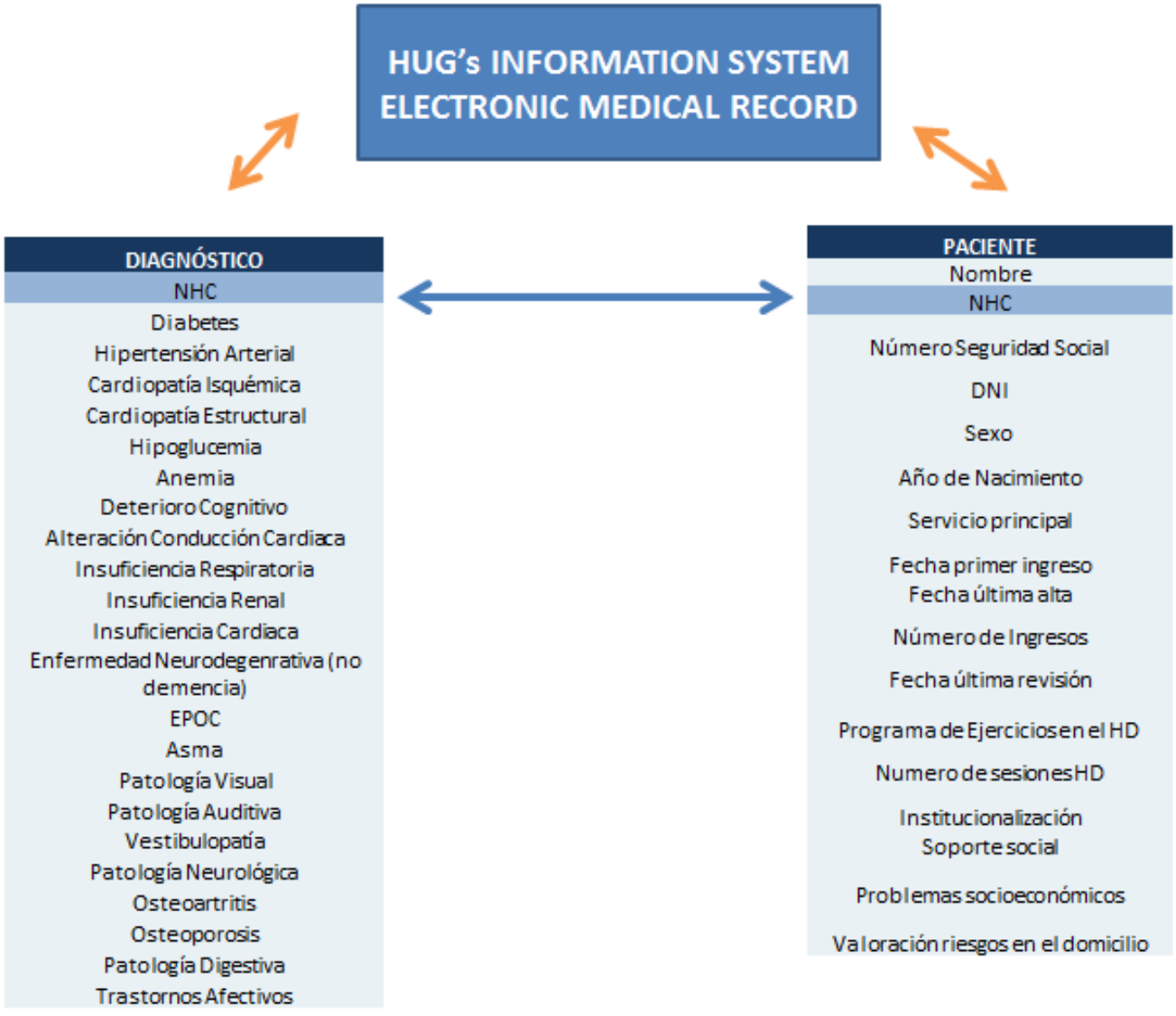
9.3 User Experience Questionnaire

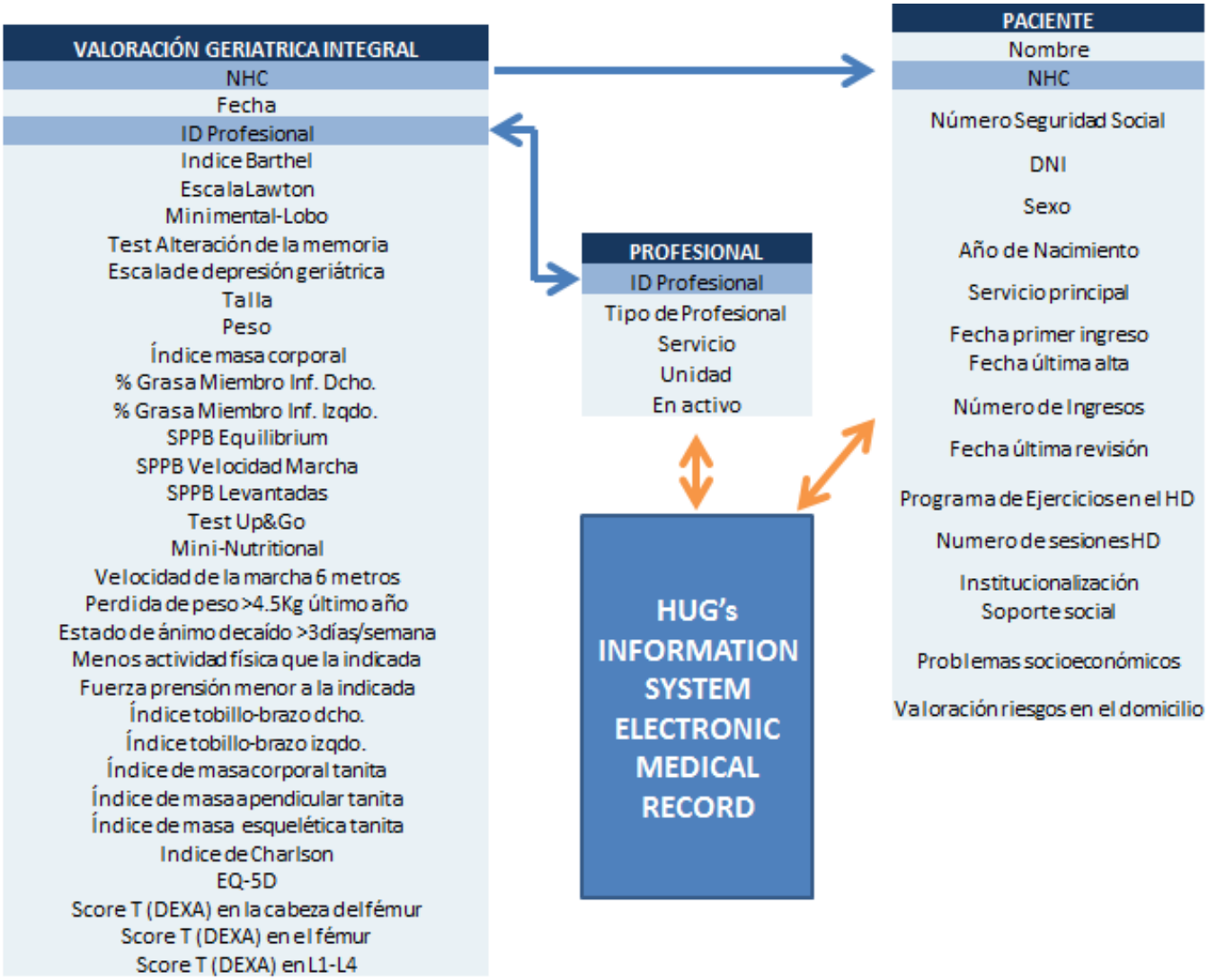
	English Version		Spanish Version (the one employed)	
	Pair of Opposite Terms	**Category**	**Par de Antónimos**	**Categoría**
1	annoying/enjoyable	Attractiveness	desagradable/agradable	Atracción
2	not understandable/understandable	Perspicuity	no entendible/entendible	Transparencia
3	creative/dull	Novelty	creativo/sin imaginación	Novedad
4	easy to learn/difficult to learn	Perspicuity	fácil de aprender/difícil de aprender	Transparencia
5	valuable/inferior	Stimulation	valioso/¨de poco valor	Estimulación
6	boring/exciting	Stimulation	aburrido/emocionante	Estimulación
7	not interesting/interesting	Stimulation	no interesante/interesante	Estimulación
8	unpredictable/predictable	Dependability	impredecible/predecible	Controlabilidad
9	fast/slow	Efficiency	rápido/lento	Eficiencia
10	inventive/conventional	Novelty	original/convencional	Novedad
11	obstructive/supportive	Dependability	obstructivo/impulsor	Controlabilidad
12	good/bad	Attractiveness	bueno/malo	Atracción
13	complicated/easy	Perspicuity	complicado/fácil	Transparencia
14	unlikeable/pleasing	Attractiveness	repelente/atractivo	Atracción
15	usual/leading edge	Novelty	convencional/novedoso	Novedad
16	unpleasant/pleasant	Attractiveness	incómodo/cómodo	Atracción
17	secure/not secure	Dependability	seguro/inseguro	Controlabilidad

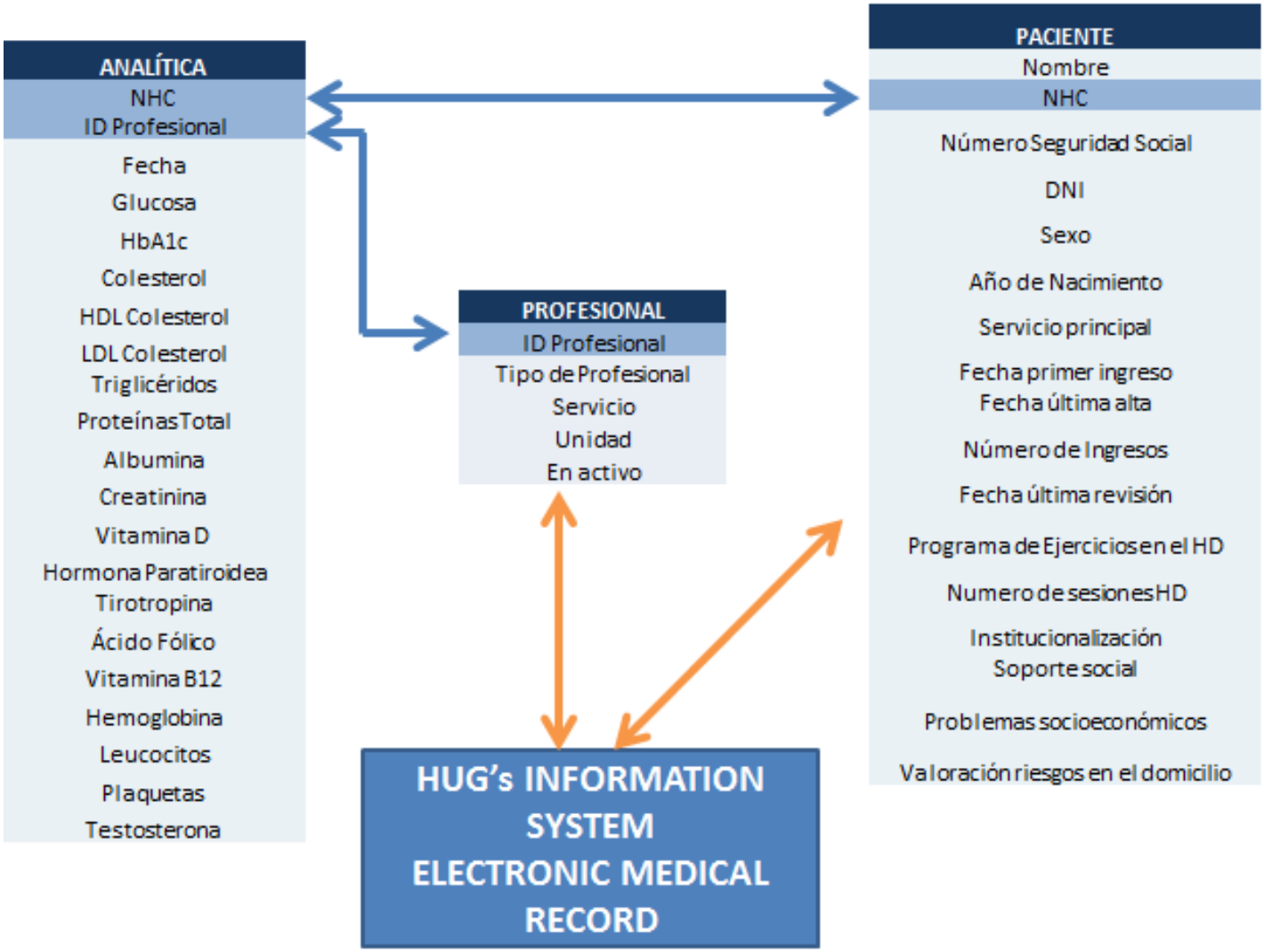
18	motivating/demotivating	Stimulation	activante/adormecedor	Estimulación
19	meets expectations/does not meet expectations	Dependability	cubre expectativas/no cubre expectativas	Controlabilidad
20	inefficient/efficient	Efficiency	ineficiente/eficiente	Eficiencia
21	clear/confusing	Perspicuity	claro/confuso	Transparencia
22	impractical/practical	Efficiency	no pragmático/pragmático	Eficiencia
23	organized/cluttered	Efficiency	ordenado/desordenado	Eficiencia
24	attractive/unattractive	Attractiveness	atractivo/feo	Atracción
25	friendly/unfriendly	Attractiveness	simpático/antipático	Atracción
26	conservative/innovative	Novelty	conservador/innovador	Novedad

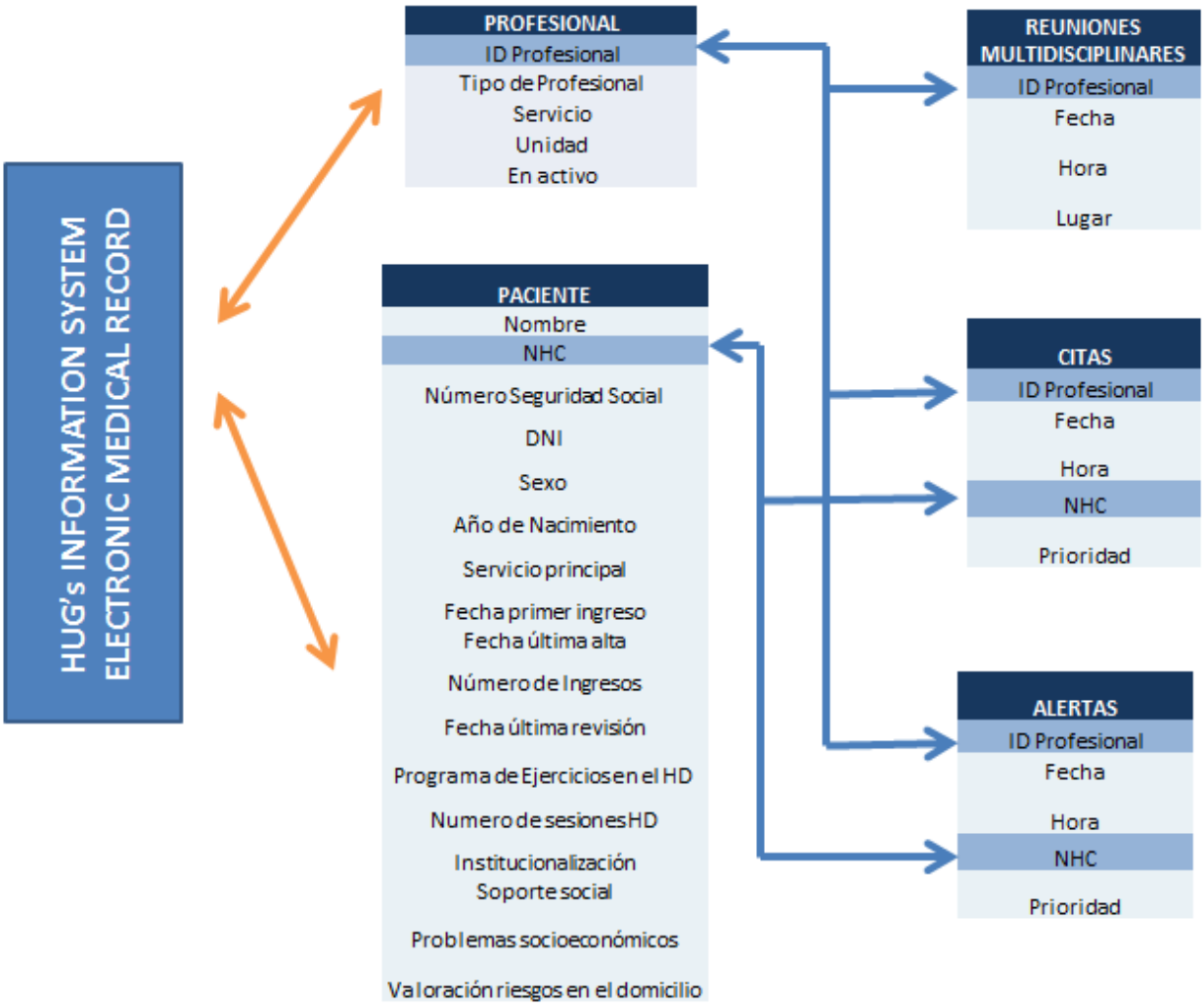
9.4 Detailed picture of the relational database and information structure

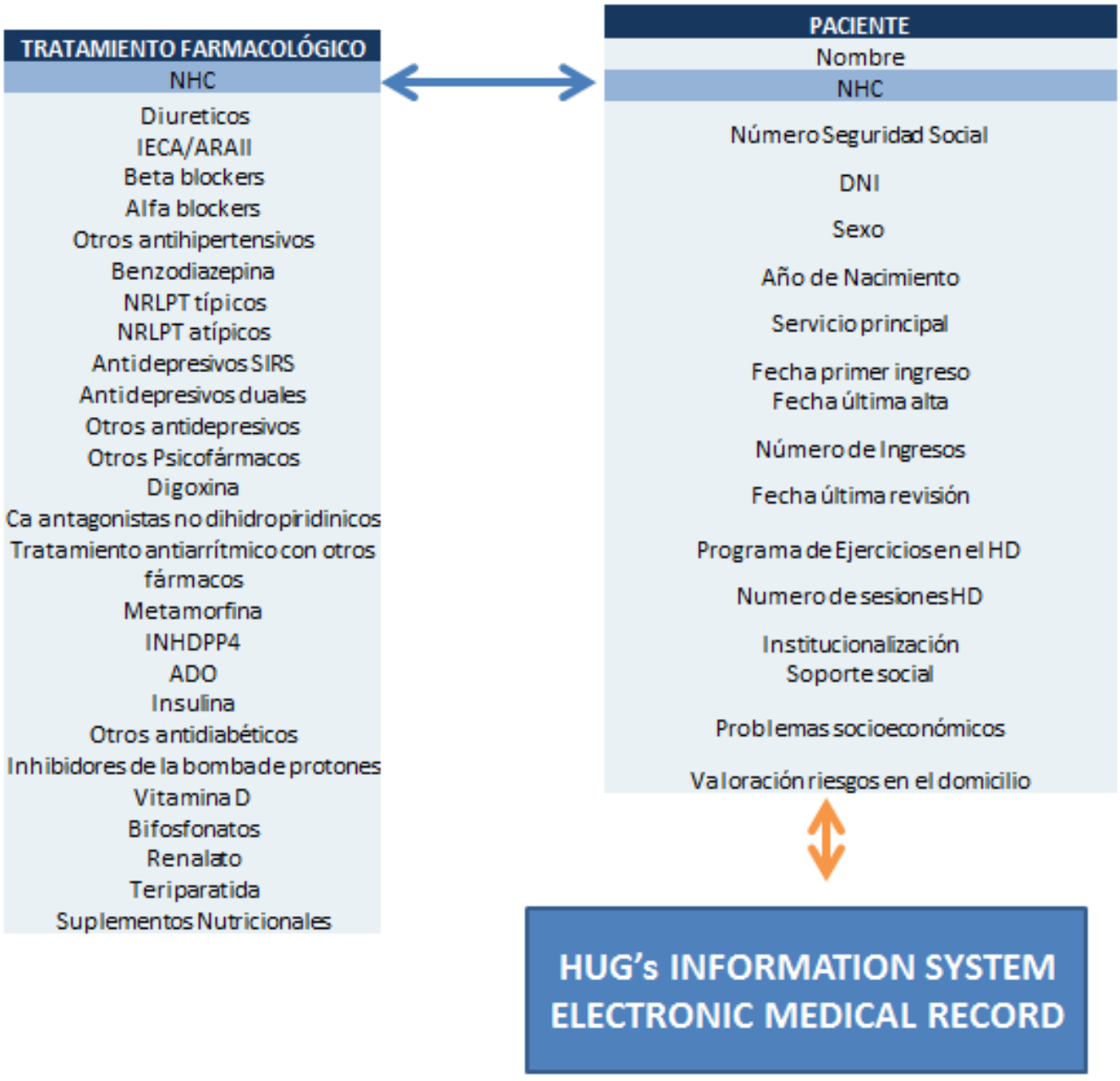
The following figures depict the organisation of data in within the Information System. Data tables are merged into a Relational Database and interconnected by 'key variables', which are the link between the different entities in the database. These relationships between tables are represented by blue arrows. Moroever some of these data tables retrieve data from the existing HIS at HUG. They are the link between the Geriatrics Service HIS and the general one in the Hospital and the information retrieval is represented by orange arrows.



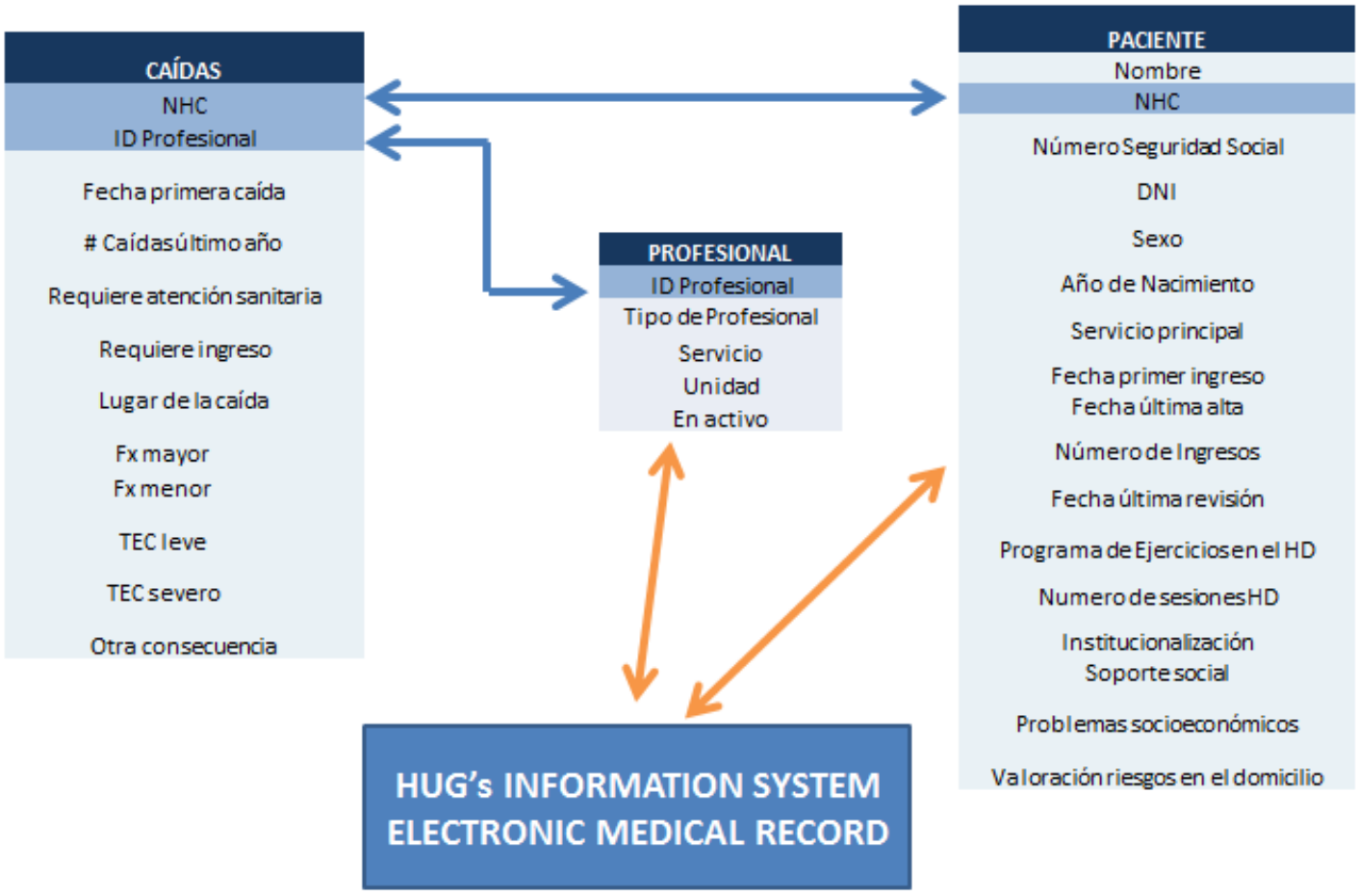

VALORACIÓN GERIATRICA INTEGRAL
NHC
Fecha
ID Profesional
Indice Barthel
Escala Lawton
Minimental-Lobo
Test Alteración de la memoria
Escala de depresión geriátrica
Talla
Peso
Índice masa corporal
% Grasa Miembro Inf. Dcho.
% Grasa Miembro Inf. Izqdo.
SPPB Equilibrium
SPPB Velocidad Marcha
SPPB Levantadas
Test Up&Go
Mini-Nutritional
Velocidad de la marcha 6 metros
Perdida de peso >4.5Kg último año
Estado de ánimo decaído >3días/semana
Menos actividad física que la indicada
Fuerza prensión menor a la indicada
Índice tobillo-brazo dcho.
Índice tobillo-brazo izqdo.
Índice de masa corporal tanita
Índice de masa apendicular tanita
Índice de masa esquelética tanita
Indice de Charlson
EQ-5D
Score T (DEXA) en la cabeza del fémur
Score T (DEXA) en el fémur
Score T (DEXA) en L1-L4
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
PROFESIONAL
ID Profesional
Tipo de Profesional
Servicio
Unidad
En activo
HUG's INFORMATION SYSTEM ELECTRONIC MEDICAL RECORD

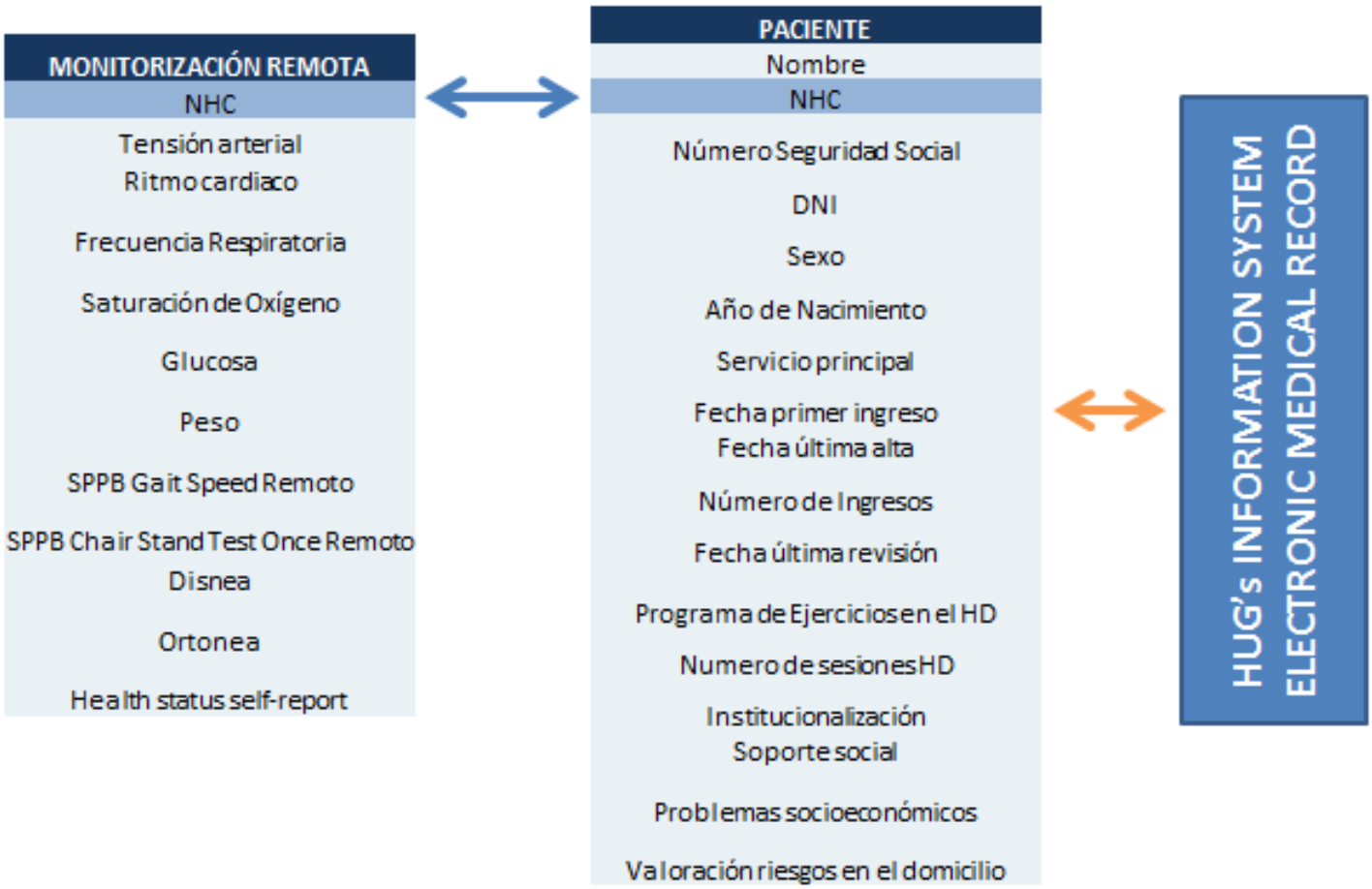

ANALÍTICA
NHC
ID Profesional
Fecha
Glucosa
HbA1c
Colesterol
HDL Colesterol
LDL Colesterol
Triglicéridos
ProteínasTotal
Albumina
Creatinina
Vitamina D
Hormona Paratiroidea
Tirotropina
Ácido Fólico
Vitamina B12
Hemoglobina
Leucocitos
Plaquetas
Testosterona
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
PROFESIONAL
ID Profesional
Tipo de Profesional
Servicio
Unidad
En activo
HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD

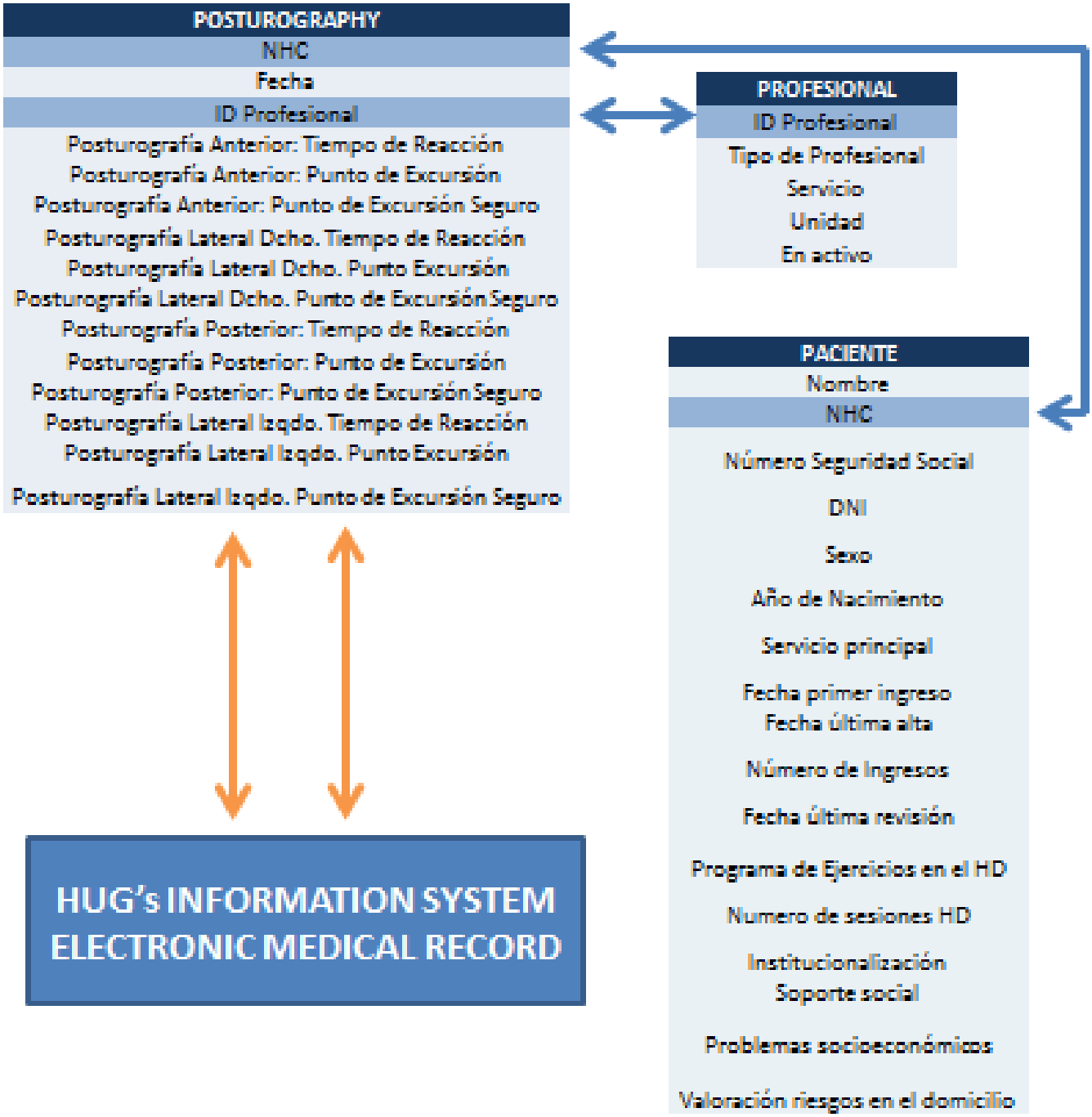

HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD
PROFESIONAL
ID Profesional
Tipo de Profesional
Servicio
Unidad
En activo
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
REUNIONES MULTIDISCIPLINARES
ID Profesional
Fecha
Hora
Lugar
CITAS
ID Profesional
Fecha
Hora
NHC
Prioridad
ALERTAS
ID Profesional
Fecha
Hora
NHC
Prioridad


TRATAMIENTO FARMACOLÓGICO
NHC
Diureticos
IECA/ARAII
Beta blockers
Alfa blockers
Otros antihipertensivos
Benzodiazepina
NRLPT típicos
NRLPT atípicos
Antidepresivos SIRS
Antidepresivos duales
Otros antidepresivos
Otros Psicofármacos
Digoxina
Ca antagonistas no dihidropiridinicos
Tratamiento antiarrítmico con otros fármacos
Metamorfina
INHDPP4
ADO
Insulina
Otros antidiabéticos
Inhibidores de la bomba de protones
Vitamina D
Bifosfonatos
Renalato
Teriparatida
Suplementos Nutricionales
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD

7


CAÍDAS
NHC
ID Profesional
Fecha primera caída
Caídas último año
Requiere atención sanitaria
Requiere ingreso
Lugar de la caída
Fx mayor
Fx menor
TEC leve
TEC severo
Otra consecuencia
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
PROFESIONAL
ID Profesional
Tipo de Profesional
Servicio
Unidad
En activo
HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD


MONITORIZACIÓN REMOTA
NHC
Tensión arterial
Ritmo cardiaco
Frecuencia Respiratoria
Saturación de Oxígeno
Glucosa
Peso
SPPB Gait Speed Remoto
SPPB Chair Stand Test Once Remoto
Disnea
Ortonea
Health status self-report
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD


POSTUROGRAPHY
NHC
Fecha
ID Profesional
Posturografía Anterior: Tiempo de Reacción
Posturografía Anterior: Punto de Excursión
Posturografía Anterior: Punto de Excursión Seguro
Posturografía Lateral Dcho. Tiempo de Reacción
Posturografía Lateral Dcho. Punto Excursión
Posturografía Lateral Dcho. Punto de Excursión Seguro
Posturografía Posterior: Tiempo de Reacción
Posturografía Posterior: Punto de Excursión
Posturografía Posterior: Punto de Excursión Seguro
Posturografía Lateral Izqdo. Tiempo de Reacción
Posturografía Lateral Izqdo. Punto Excursión
Posturografía Lateral Izqdo. Punto de Excursión Seguro
PROFESIONAL
ID Profesional
Tipo de Profesional
Servicio
Unidad
En activo
PACIENTE
Nombre
NHC
Número Seguridad Social
DNI
Sexo
Año de Nacimiento
Servicio principal
Fecha primer ingreso
Fecha última alta
Número de Ingresos
Fecha última revisión
Programa de Ejercicios en el HD
Numero de sesiones HD
Institucionalización
Soporte social
Problemas socioeconómicos
Valoración riesgos en el domicilio
HUG's INFORMATION SYSTEM
ELECTRONIC MEDICAL RECORD

10 Bibliography

- Abras, C., Maloney-Krichmar, D., & Preece, J. (2004). User-centered design.*Bainbridge, W. Encyclopedia of Human-Computer Interaction. Thousand Oaks: Sage Publications*, *37*(4), 445-456.Preece, J. R., & Rogers, Y. (2007). SHARP (2002): Interaction Design: Beyond Human-Computer Interaction. *Crawfordsville: John Wiley and Sons, Inc. Answers. com Technology*.

- Axelsson, R., & Axelsson, S. B. (2006). Integration and collaboration in public health-a conceptual framework. *International journal of health planning and management*, *21*(1), 75.

- Bandeen-Roche, K., Xue, Q. L., Ferrucci, L., Walston, J., Guralnik, J. M., Chaves, P., ... & Fried, L. P. (2006). Phenotype of frailty: characterization in the women's health and aging studies. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *61*(3), 262-266.

- Bouzón, C. A., Torregrossa, R. P., Larraín, P. P. M., & Mañas, L. R. (2010). Efectividad de la revaloración de ingresos de pacientes con mala situación funcional. *Revista Española de Geriatría y Gerontología*, *45*(1), 19-21.

- Clegg, A., Young, J., Iliffe, S., Rikkert, M. O., & Rockwood, K. (2013). Frailty in elderly people. *The Lancet*, *381*(9868), 752-76

- Costa,J. (2011). Personas: putting the focus back on the user. *UX Booth*. Available at: http://www.uxbooth.com/blog/personas-putting-the-focus-back-on-the-user/

- Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). “Mini-mental state”: a practical method for grading the cognitive state of patients for the clinician.*Journal of psychiatric research*, *12*(3), 189-198.

- Fried, L. P., Tangen, C. M., Walston, J., Newman, A. B., Hirsch, C., Gottdiener, J., ... & McBurnie, M. A. (2001). Frailty in older adults evidence for a phenotype. *The Journals of Gerontology Series A: Biological Sciences and Medical Sciences*, *56*(3), M146-M157.

- Gorsky, M. (2008). The British National Health Service 1948–2008: a review of the historiography. *Social History of Medicine*, *21*(3), 437-460.

- Gröne, O., & Garcia-Barbero, M. (2001). Integrated care: a position paper of the WHO European Office for Integrated Health Care Services. *International journal of integrated care*, *1*.

- Haux, R. (2006). Health information systems–past, present, future.*International journal of medical informatics*, *75*(3), 268-281.

- Karanikolos, M., Mladovsky, P., Cylus, J., Thomson, S., Basu, S., Stuckler, D., ... & McKee, M. (2013). Financial crisis, austerity, and health in Europe.*The Lancet*, *381*(9874), 1323-1331.

- Kodner, D. L., & Spreeuwenberg, C. (2002). Integrated care: meaning, logic, applications, and implications–a discussion paper. *International journal of integrated care*, *2*

- Kutzin, J. (2011, November). Bismarck vs. Beveridge: is there increasing convergence between health financing systems?. In *First annual meeting of SBO network on health expenditure* (pp. 21-22).

- Lawton, M. P., & Brody, E. M. (1970). Assessment of older people: self-mantaining and instrumental activities of daily living, *Nursing Research*, *19*(3), 278.

- Mahoney, F. I. (1965). Functional evaluation: the Barthel index. *Maryland state medical journal*, *14*, 61-65.

- Mansoa, F. J, Sánchez, A, Villalba, E, & Peinado, I., (2015). *Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS 3)– Veterans Health Administration. (USA) Case Study Report* (IN PRESS) Institute for Prospective and Technological Studies, Joint Research Centre

- OECD (2015), OECD Family Database, OECD, Paris. Available at www.oecd.org/social/family/database.htm)

- Organization for Economic Cooperation and Development (OECD) Staff. (2013). *Health at a Glance 2013: OECD Indicators*. OECD, available at http://dx.doi.org/10.1787/health_glance-2013-en

- Panella, M., Marchisio, S., & Di Stanislao, F. (2003). Reducing clinical variations with clinical pathways: do pathways work?. *International Journal for Quality in Health Care*, *15*(6), 509-521

- Peinado, I., Villalba, E., Mansoa, F. J., & Sánchez, A. (2015a). *Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS 3)–Diabmemory (Austria) Case Study Report* (No. JRC95122). Institute for Prospective and Technological Studies, Joint Research Centre.

- Peinado, I., Villalba, E., Sánchez, A, & Mansoa, F. J., (2015b). *Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS 3)– MOMA and Maccabi Healthcare Services in Israel-Case Study Report* (IN PRESS) Institute for Prospective and Technological Studies, Joint Research Centre.

- Porter, D. (1999). *Health, civilization, and the state: a history of public health from ancient to modern times*. Psychology Press.

- Rauschenberger, M., Schrepp, M., Cota, M. P., Olschner, S., & Thomaschewski, J. (2013). Efficient measurement of the user experience of interactive products. How to use the user experience questionnaire (ueq). example: spanish language version. *IJIMAI*, *2*(1), 39-45.

- Rodríguez Mañas, L., Solano Jaurrieta, J.J. (2001) *Bases de la atención sanitaria al anciano*. Sociedad Española de Medicina Geriátrica.

- Rosson, M. B., & Carroll, J. M. (2009). Scenario based design. *Human-computer interaction. Boca Raton, FL*, 145-162.
- Rubenstein, L. Z., & Wieland, D. (1990). Comprehensive geriatric assessment. In *Annual Review of Gerontology and Geriatrics* (pp. 145-192). Springer Berlin Heidelberg.
- Starfield, B. (1998). *Primary care: balancing health needs, services, and technology*. Oxford University Press, USA.Personal paper: how to get the best health outcome for a given amount of money Matthew Sutton (1997). Centre for Health Economics, University of York, York YO1 5DD Matthew Sutton, research fellow
- Strawbridge, W. J., Shema, S. J., Balfour, J. L., Higby, H. R., & Kaplan, G. A. (1998). Antecedents of frailty over three decades in an older cohort. *The Journals of Gerontology Series B: Psychological Sciences and Social Sciences*, *53*(1), S9-S16.
- Stuckey, H. L. (2013). Three types of interviews: Qualitative research methods in social health. *Journal of Social Health and Diabetes*, *1*(2), 56.
- Tideiksaar, R. E. I. N. (1988). Falls in the elderly. *Bulletin of the New York Academy of Medicine*, *64*(2), 145.
- United Nations, Department of Economic and Social Affairs, Population Division (2013). World Population Prospects: The 2012 Revision, Key Findings and Advance Tables. Working Paper No. ESA/P/WP.227.
- Villalba, E., Casas, I., Abadie, F., & Lluch, M. (2013). Integrated personal health and care services deployment: experiences in eight European countries.*International journal of medical informatics*, *82*(7), 626-635.
- Villalba, E., Sánchez, A, Peinado, I., & Mansoa, F. J., (2015). *Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS 3)–Diabmemory (Austria) Case Study Report* (IN PRESS) Institute for Prospective and Technological Studies, Joint Research Centre.
- Villalba, E., Sánchez, A, Peinado, I., & Mansoa, F. J., (2015). *Strategic Intelligence Monitor on Personal Health Systems Phase 3 (SIMPHS 3)– Geriatrics Service. University Hospital of Getafe (Spain) Case Study Report* (IN PRESS) Institute for Prospective and Technological Studies, Joint Research Centre
- Weisz, G. (2003). The emergence of medical specialization in the nineteenth century. *Bulletin of the History of Medicine*, *77*(3), 536-574.

- Winograd, C. H., Gerety, M. B., Chung, M., Goldstein, M. K., Dominguez Jr, F., & Vallone, R. (1991). Screening for frailty: criteria and predictors of outcomes. *Journal of the American Geriatrics Society*, *39*(8), 778-784.
- Wieland, D., & Hirth, V. (2002). Comprehensive geriatric assessment. *Cancer control: journal of the Moffitt Cancer Center*, *10*(6), 454-462.
- Xue, Q. L. (2011). The frailty syndrome: definition and natural history. *Clinics in geriatric medicine*, *27*(1), 1-15.
- Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1983). Development and validation of a geriatric depression screening scale: a preliminary report. *Journal of psychiatric research*, *17*(1), 37-49.
- Zweifel, P., Felder, S., & Meiers, M. (1999). Ageing of population and health care expenditure: a red herring?. *Health economics*, *8*(6), 485-496.